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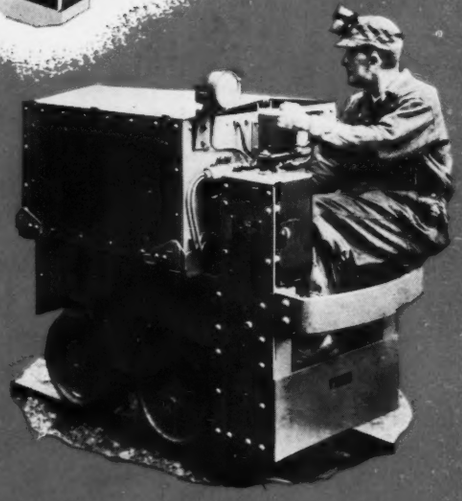

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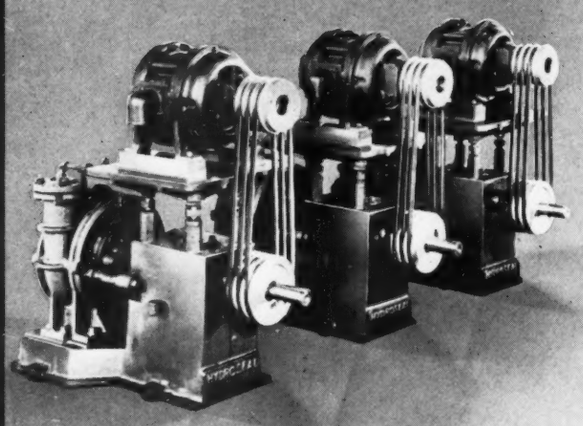

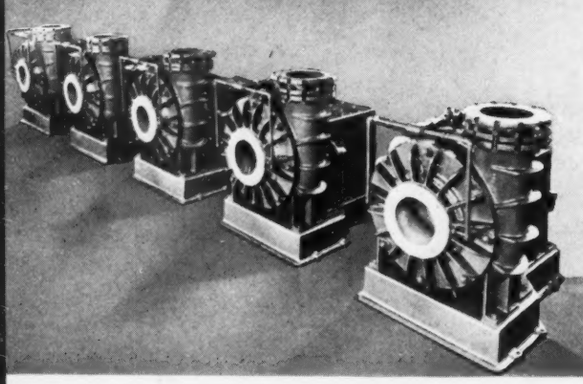

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Engineering and Mining Journal

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WILLARD CHEVALIER
Vice-President

The Golden Queen, originally known as the Silver Queen, and California's most interesting mine today, is now a little more than two years old. In this time the mine has become a steady producer and now has a 350-ton cyanide plant that is worthy of attention. Boasting nothing outstanding of a metallurgical sort in its flowsheet, it nevertheless utilizes the most modern equipment to good advantage. In an early issue it will be described in some detail by Otto Wartenweiler, long and well known in the Southwest and now vice-president of the Smith-Emery Company, chemist-engineers, of Los Angeles.

*

Improvements in sanitation and mining practice on the gold mines of the Witwatersrand have lowered the death rate from disease from 71.7 per 1,000 in 1903 to 7.5 per 1,000 in 1934. The death rate from accidents was down to 1.85 per 1,000 in the year last mentioned. Considering the exceptional conditions incident to the maintenance of a working force of 285,000 natives, the figures reflect distinctive credit on the men responsible for so noteworthy a record.

*

Underground Warnings of fire or danger are sent through compressed-air lines in the Nundydroog mine workings, in the Kolar gold field, Mysore, India, by the introduction of eucalyptus oil into the mains. The vapor soon permeates every working point in the mine. Safety rescue chambers are also provided, a central rescue chamber is maintained, and gas masks are in readiness for the use of those whose duty requires them to shut fire doors, operate hoists, and to assist in the rescue of miners in danger and in their withdrawal from the mine. Where necessary, all underground workers are entitled to similar protection.

●

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Japan is planning to hold a Grand International Exhibition in 1940, from Feb. 11 to July 31, in commemoration of the 2,600th anniversary of the enthronement of Emperor Jimmu, first ruler of the Japanese Empire. The exhibition is to be held in Tokyo and Yokohama. An announcement in "Japan Today and Tomorrow," year book of the *Osaka Mainichi,* is to the effect that the Japanese Government will exempt from duty foreign goods imported for display at the exhibition.

*

Autogenous Smelting of copper concentrates with oxygen-enriched air, the process avoiding roasting among its features, presents interesting possibilities for the future, according to T. E. Norman, of Toronto, who has given them exhaustive study. His calculations and conclusions merit the attention of all metallurgists and will be presented in these pages soon.

*

Not Gold but Pepper was the objective sought by the early Portuguese explorers in their quest for a water route to the Indies. They maintained a virtual monopoly of imports until the seventeenth century. When Alaric assailed the gates of Rome in 408 A.D. he demanded as the city's ransom 5,000 pounds of gold, 30,000 pounds of silver, and 3,000 pounds of pepper. There was spice to adventure in those days.

*

Diamonds are reported to have attained normal demand. Sales of rough stones in 1935 exceeded those in 1934 by 100 per cent. The industrial diamond market has risen 30 per cent, and a shortage of supplies is developing, owing to the fact that many diamond-producing properties are still shut down. Producers therefore face the future with confidence.

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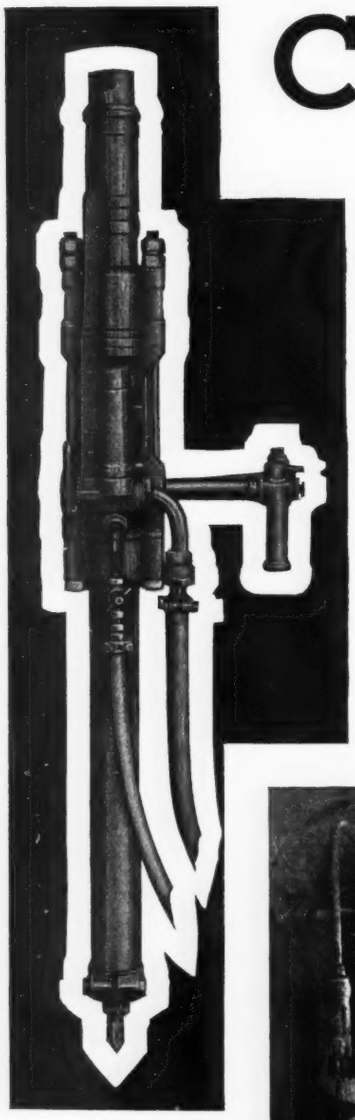

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Volume 137 MAY 1936 Number 5

Exemption From Assessment Work Becoming a Vested Right

HOW LONG will the Congress continue to exempt holders of unpatented mineral claims from the legal requirement of annual assessment work to the value of $100 per claim? This exemption was first made during the World War as a measure of labor conservation, so that all able-bodied men could serve in the Army or in the production of war materials. Congress first waived the requirement for the period of the War and until December 31 of the year following that in which the War might be concluded. But other excuses arose for extending the period of exemption long after the War. And finally the depression seemed an adequate reason for relieving prospectors and others of the necessity of spending money for assessment work.

Early this year bills were again introduced in the House and in the Senate granting exemption for the current fiscal year ending 12 o'clock noon, July 1, 1936. Believing that exemption was not in the best interest of the mining industry and should be brought to an end, we sought a cross-section of opinion among representative mine operators and mining engineers. Their attitude, which is expressed in excerpts from letters published on the next two pages, is almost unanimous in opposition to further exemption. The Senate, however, had passed the bill before we could transmit this opinion of the industry. In reply to our letter quoting this opinion, the Chairman of the Senate Committee on Mines and Mining said he thought his committee had "reached the same conclusions" and that it was "with much reluctance that the bill was favorably reported this year." Evidently the committee did not think enough of its own conclusions to stand by them. No reply was received from the House committee, and that body likewise passed the bill. In a final effort to defeat the measure, we urged the President to veto the bill, and offered the consensus of industry opinion in support of that action. Nevertheless, he signed the bill on April 25.

Exemption seems to be well on its way to become a vested right, like many another form of relief granted during the depression. The longer it is continued, the harder it will be to dislodge the beneficiaries from their privileged position. Annual assessment work is little enough return to the nation for the privilege of holding unpatented mineral claims, and the requirement should be rigidly enforced.

Speaking of Taxes

AMERICAN INDUSTRY is about to experience the painful privilege of paying the piper. Or, in terms more appropriate to the grand manner of public spending during the depression, it is about to compensate the entire New Deal orchestra which, for several years past, has been rendering a roundelay or medley entitled Relief, Recovery, and Reform. Contemplating the Revenue Act of 1936, one realizes suddenly that the "breathing spell" has terminated in a sinking spell.

As introduced in the House, the tax bill embodies the President's proposal for a complete change in methods of taxing corporations. The basis is a graduated levy on undistributed profits or surpluses. In other words, a tax on thrifty and provident management that knows how wise it is not to pay out all the earnings, but to reserve some part of them for emergencies. If a mining corporation uses all its earnings for capital expenditure and payment of debts, distributing nothing to stockholders, the tax will lie on the entire earnings at the highest rate in the sliding scale.

The plan is fantastic for either large or small corporations. It will handicap industrial expansion, either by modernization of old, or development of new, industries. It is designed to force corporations to follow the dictates of rigid regimentation, rather than rely on the sound business judgment of their boards of directors. Its attempt to redistribute wealth will lower our standard of living and we shall all share the poverty, not the wealth, of the nation.

Consider the single rôle of surpluses as cushions against depression. From 1930 to 1934 inclusive, American business paid out more than it received by an aggregate of nearly 27 billion dollars. The Government's deficit for the last four of those years was only 11 billion dollars. Did business or government do more to alleviate distress arising from unemployment? Without the surpluses actually drawn upon by private industry, no government could have prevented complete economic collapse. And yet it is now proposed forcibly to prohibit the accumulation of savings. The mining industry should use every legitimate means at its command to restrain the Administration from this headstrong folly.

How Long Shall Annual Assessment Work Be Suspended?

EDITOR'S NOTE: *The Administration at Washington has again exempted holders of unpatented mineral claims from the requirement of annual assessment work for the current year. Prior to enactment of the Bill we invited comment on the proposal from engineers and operators actively engaged in mining. These comments, as excerpted below, were submitted to Congress and to the President, but without avail.*

I AM OPPOSED to the special act now before Congress providing for the suspension of annual assessment work on mining claims in the United States and Alaska, for the reason that the suspension of such work is not beneficial to the mining industry. The suspension of this work for several years past has not benefited mine operators nor genuine prospectors. The only benefit has been to claim holders, who have been able to retain possession of mineral lands purely for speculative purposes. It is obvious, but the point may be emphasized, that while mineral land is idle no mines can be developed; and the industry requires the development of new mines continually to replace those depleted. The opening up of new mines might be also a good way of coping with the national unemployment problem. JULIAN BOYD
Consulting Mining Engineer, Los Angeles, Calif.

• •

OWNERS of unpatented mining claims can be classified generally as follows:

(1) Corporations, now operating mines, with ample capital to protect their holdings.

(2) Inadequately financed corporations, owning partly developed prospects.

(3) Individuals: those "who have," and those "who have not."

Most of the corporations operating producing mines have already done sufficient work to cover normal assessment-work requirements for this year on their unpatented ground.

Mining corporations of Class 2 are seriously handicapped in obtaining money under present conditions. They have no standing at the banks or at relief agencies. Those of this class that have not already performed their annual assessment work should not be required to do so. I do not agree with those who think the industry can be benefited by claim jumpers' wiping out the holdings of corporations that have partly developed prospects and that are now unable to protect their ground. The depression has been hard on the optimists who are willing (when they are able) to risk their money at long odds in the development of prospects.

The individuals who own most of the unpatented claims (not including those owned by corporations) are the prospectors and miners, a majority of whom have obtained their ground by location. Shortage of "optimists" with money, coupled with a shortage of jobs, makes it difficult or impossible for some of the claim owners of this class to do their assessment work. If Congress does not exempt claims from assessment-work requirements this year, more than half will probably be relocated by their present owners, but in "Cousin Kate's" name.

My conclusions are that Congress should continue to assist owners of unpatented claims by waiving assessment-work requirements until such time as Class 2 corporations and individuals have a reasonable chance of obtaining the necessary funds to protect their holdings. EDWARD H. SNYDER
Combined Metals Reduction Company, Stockton, Utah.

MY REACTION to the question submitted is that assessment work should be done and should not be exempted as it has been for the past few years. Surely, since unemployment still prevails to so large a degree, this assessment work itself will give employment to quite a few men, which, therefore, is to a good end. O. E. SCHIFFNER
Lava Cap Gold Mining Corporation, Nevada City, Calif.

• •

ENGINEERS AND OPERATORS with whom I have discussed the matter are practically unanimous in stating that this (suspension) has a very detrimental effect on new developments, not from the standpoint of the assessment primarily, but owing to the fact that any substantial company entering a new field has varying amounts of difficulty. In some cases it amounts to rather substantial payments to clear up the confusion in title, owing to the fact that where assessment has been waived for a number of years, title may be reclaimed by any formerly abandoned location. This has been done in a great many instances, particularly in the new placer developments here in southern Idaho. GORDON C. SMITH
Mining Engineer, Boise, Idaho.

• •

THERE IS NO QUESTION whatever that requirement for annual assessment work should be resumed, in accordance with the intention of the original act. My recollection is that the suspension of such requirement was started during the War, when we were actually short of man-power. This temporary arrangement should never have been carried on into the depression, and now certainly there is no excuse for it. *Mining Engineer,* ROBERT H. SAYRE
Denver, Colo.

• •

THE REASONS for requiring annual assessment work are now as valid as in pre-depression years. Energetic and legitimate location and exploration work is being held up. The suspension law puts a premium on inactivity. HARRISON SCHMITT
Consulting Mining Geologist, Hanover, N. M.

• •

MY EXPERIENCE leads me to emphasize the fact that the intelligent, hard-fisted prospector who owns mining claims by location is quite willing to do the annual one hundred dollars' worth of work required by law on each claim; but the individual or corporation that has never done the full amount of work specified and is trying to hold a number of claims by "skimping" assessment work will be glad to take advantage of the law of suspension and go on obstructing the true intent of the assessment requirement. The continued suspension of this requirement has had the effect of postponing the development of some promising prospects. The legislation was intended to benefit the impecunious prospector, not to permit advantage to parties amply able to comply with the law. It is therefore harmful in its results. FRANK L. SIZER
Mining Engineer, San Francisco, Calif.

IN MY OPINION any further abatement of this requirement would be a mistake. It should be realized this assessment is not a tax. The Government obtains no direct benefit from it. Its purpose is to encourage and stimulate mining and mineral development on the public domain. The prospector is required, for the privilege of discovering something valuable that would be his own if successful, to do a small amount of work each year. This seems very little for what he might obtain. As a matter of fact, everyone who has had much experience in mining on public lands in the West knows there is a lot of humbug and dishonesty in relation to the amount of work actually performed. A prospector picks about in a ten-foot hole or outcrop, throws out a few shovelfuls of muck, and swears he has done a hundred dollars' worth of work. He knows in most cases this claim or assertion is not likely to be disputed. If, on the other hand, he thinks such may happen and that he has possibly a good prospect or claim, he takes no chance and does all the law requires of him. This lax system has much to condemn it, for it is not only dishonest but prevents anyone else from taking over the claim and doing the required development work. Consequently, the legitimate growth of the district is hampered and checked. I have known instances of a single individual holding as many as fifty claims which no one could touch as long as the assessment work was done, assumed to have been done, or suspended by law. Such a situation is obviously so wrong and unfair to others that further comment would seem to be unnecessary. F. LYNWOOD GARRISON
Mining Engineer and Economic Geologist, Philadelphia, Pa.

• •

OUR MINING LAWS are very liberal, I think, and they should be modified only in cases of emergency. This emergency has passed, and assessment work should be insisted upon as a matter of providing employment. In my long service with the Government I had a good opportunity to see how such laws as this were abused. I recall one case where two men held 200 claims under location without doing any work on them. Such a procedure is certainly a greater harm to the mining industry than the insistence upon performance of the assessment work. LEROY A. PALMER
Consulting Engineer, San Francisco, Calif.

• •

I DO NOT FAVOR further suspension of assessment work on unpatented mining claims. I am confident that proper and intelligent performance of this work will prove advantageous not only to the prospectors and other claim owners, but to investors and to our country. If the claims are of *no value*, the sooner the owner determines this, drops them, and applies his energy elsewhere, the better. If the contrary, well-planned work should make production possible, or the securing of capital for exploration easier.

The resumption of annual work will also aid a large number of prospectors who obtain funds by doing assessment work on near-by properties owned by companies and individuals who must hire it done. True, there will be some so unfortunate as to be unable to pay for the required work, or to perform it personally, but if the ground is attractive it should be possible to obtain assistance in return for an interest in the property. If not, the holders of these claims have had several years' free occupancy, and no landlord can forego his rent indefinitely and pay his taxes. Even at best, thousands of claims are held with merely nominal work. GEORGE A. PACKARD
Mining Engineer, Boston, Mass.

• •

THESE SUSPENSIONS, I believe, are inherently wrong, serving principally to maintain in idleness areas that might be made productive. On the one hand are the poor men, attempting to hold more than they can possibly develop, who should relinquish; on the other hand are the well-to-do, who need no relief. CHARLES A. CHASE
General Manager, Shenandoah-Dives Mining Company, Silverton, Colo.

• •

I FEEL that, however urgent the reasons for suspending annual assessment on mining claims may have seemed during the early stages of the depression, they are now outweighed by the consideration which made it wise in the first place to enact such requirements for those seeking to acquire public lands for mineral exploration. To allow claimants to retain possessory title indefinitely without obligation to explore imposes obstacles to development which are against public interest. No private individual or company would grant any such option. The Government should not be expected to. ARTHUR NOTMAN
Mining Engineer and Geologist, New York, N. Y.

• •

ASSESSMENT WORK as a method of holding title to claims should be abandoned forever. This method of holding claims is wasteful; it encourages dishonesty; it tends to discourage prospecting, because of the insecurity of title which nearly always results. A prospector can go into almost any old-established mining district and develop a claim. If he finds a profitable orebody, the chances are nine out of ten that he will have a lawsuit contesting his ownership to the claim. Our mining laws should be completely revised. In place of assessment work, residence on mineral land should convey the right to hold title to one claim only, and additional claims should be held by paying the Government an annual fee of $5 to $10 per claim. In this way the public domain would be kept open to legitimate prospecting, the doubt and uncertainty as to titles would be removed, and there would be a greater incentive for the search of new mines. Your championship of a revision of our mining laws, especially as affecting assessment work, might result in great good. MORRIS J. ELSING
Tucson, Arizona.

SUSPENSION of the statutory annual assessment requirement on mining claims was no doubt of direct benefit to a limited group of prospectors and operators of limited capital, for a couple of years. In California a large majority of those interested in the development of the mineral industries opposed the continuance of this "moratorium" last year. Any further waiving of the assessment requirement will retard progress and development far outweighing any advantage to a limited number of individuals or "fly-by-night" companies some of which have been holding greater areas of potential mineral ground than they could otherwise handle. This prevents development by others who would work. It has also reduced the necessity for employment of labor by many companies that can afford to pay for it. WALTER W. BRADLEY
Division of Mines, State of California.

• •

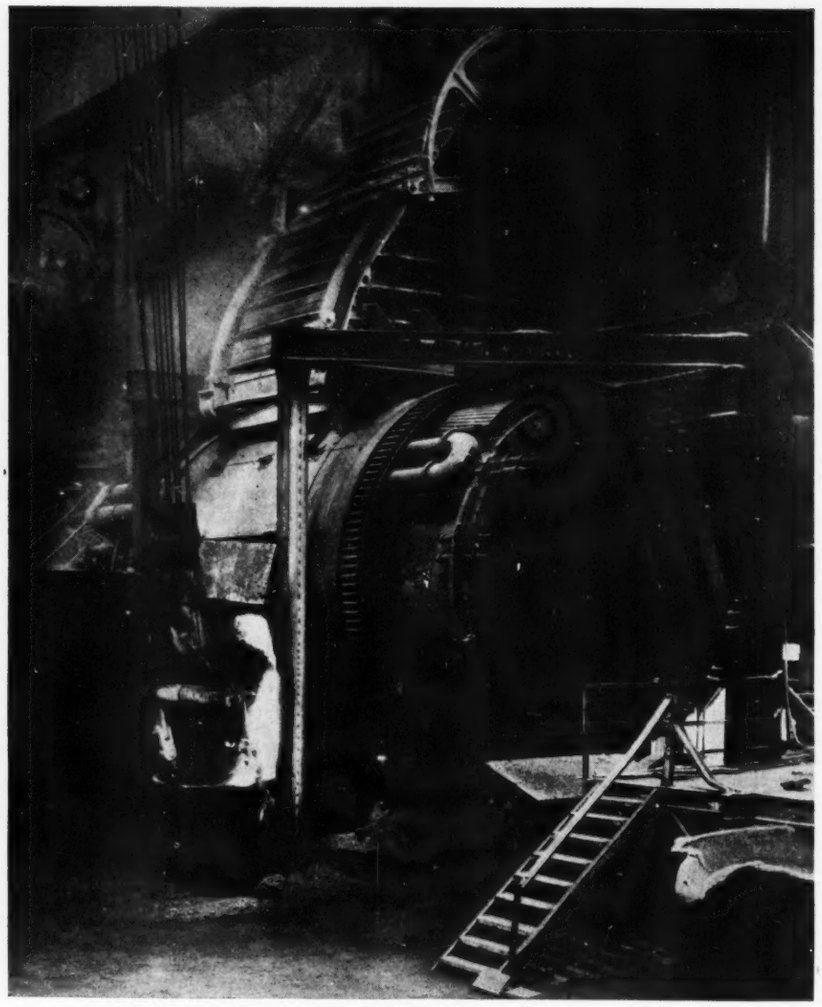
THE UNITED STATES SENATE has again, I note, passed a measure to suspend the annual assessment work on mining claims. From my observations, this has caused a good deal of harm in the past and very little if any benefit except to allow the filing on mining claims and holding them through the years without effort. There are any number of filings that come under this heading. There is more incentive to develop mining properties in this country than ever before. Those who cannot keep up with the procession at this time should no longer be allowed to do the "dog-in-the-manger" act. I am opposed without reservation to this measure.
JAMES D. STEWART
Consulting Mining Engineer, Auburn, Calif.

• •

THE SUSPENSION of assessment work on mining claims was allowed at a time when it was an absolute necessity to help the owners of mining claims, but as the time has happily arrived when this situation does not exist, I believe that there should be no further suspension. Save this favorable action on the part of the Government until it is needed again, and let's hope that we will never need suspension of assessment work again. But let us not ride a free horse to death. I am certain that this view will be disapproved by many mining claim owners, but if they would look this situation squarely in the face, I do not believe they will disapprove of my stand. W. J. LORING
Arizona Comstock Corporation, Virginia City, Nev.

• •

I AM DISTINCTLY of the opinion that the suspension of annual assessment work on mining claims has reacted against the interest of the mining industry. It has prevented the location of mineralized ground by bona fide prospectors and has permitted the holding of a group of claims in size out of all proportion to the financial resources of those holding the claims in question.
S. H. BALL
Rogers, Mayer & Ball, Mining Engineers, New York, N. Y.



A 13x30-ft. PEIRCE-SMITH CONVERTER in service in a copper smelter in the Western United States. Units of this type and size are to be found in many of the newer installations at copper-reduction plants

An Inquiry Into Converter Capacity

Calculations are presented for a 13x30-ft. Peirce-Smith unit under varying conditions of operation

John S. Stewart

Associated with Archer E. Wheeler

25 Broadway, New York

"WHAT are the capacities of copper converters in America?" This was the question asked by a client who had a number of copper smelters built, or contemplated to be built, with locations at various altitudes and whose mattes were of varying grades of copper.

A search was made of all published data on converter practice, and it was found that there were so many variable factors that a comparison of results from different plants would show such inconsistencies that the tabulation of these data would be without value to anyone unless all the factors given corresponded to his particular conditions; or, unless it was used as a basis for making a thorough study of the whole problem.

Data covering the daily capacities of converters, blowing varying grades of mattes and located at various altitudes, have never been published, nor is it generally known what these capacities really are.

In most smelters of any size, one of four types or sizes of converters is generally used; namely, the 13x30-ft. or the 10x26-ft. Peirce-Smith converter, or the 20-ft. or the 12-ft. Great Falls type of converter. In many of the new installations, the 13x30-ft. Peirce-Smith converter has been adopted.

In the following an attempt has been made to ascertain the daily capacity of a 13x30-ft. Peirce-Smith converter, under varying conditions of operation. As so many different factors affect the operation, a number of estimates were perforce assumed which were believed to be average figures. But no two plants have the same factors throughout; also, certain assumptions were made which are not absolutely accurate, but for simplification of the calculations they had to be used. Therefore, the results shown hereafter can be looked upon only as an approximation.

Wherever tons are mentioned in this article, metric tons are meant, and the volumes used are given in cubic meters.

Matte Composition and Theoretical Air Required—A study of matte com-

position was made, using the matte analyses of various smelters. It was generally found that the Cu + Fe + S = 95 per cent, with the sulphur varying uniformly from 27 per cent for a 15 per cent copper matte to 22 per cent for a 55 per cent copper matte; from this, the amount of iron and sulphur to be oxidized was determined for any grade of matte.

The theoretical weight of air required to oxidize the iron and sulphur was first calculated, so as to eliminate the consideration of temperature and pressure. Air was assumed to consist of 23.1 per cent oxygen by weight and 76.9 per cent nitrogen by weight, this comparing with 20.9 per cent oxygen by volume and 79.1 per cent nitrogen by volume. The weight of one cubic meter of dry air at 0 deg. C. and 762 mm. pressure is 1.293 kg.

The oxidation of iron was calculated to FeO—1,000 kg. of Fe requires 285.7142 kg. of oxygen, or 1,236.858 kg. of air. The oxidation of sulphur was calculated to SO_2—1,000 kg. of S requires 1,000 kg. of oxygen, or 4,329.004 kg. of air. The matte compositions are found in Table I.

Volume of One Ton of Air at Different Altitudes, at 0 Deg. C. and at 20 Deg. C.—The theoretical volume of air required to convert 1 ton of matte, of different grades, will of course be dependent on the density of the air, due to the temperature and the atmospheric pressure.

Two temperatures have been used in these calculations: 0 deg. C. and 20 deg. C. (32 deg. F. and 68 deg. F.), which represent average winter and summer temperatures. For the sake of brevity herein, calculations for 20 deg. C. temperatures were not carried to conclusion. The atmospheric pressures are determined by the altitude.

The weight of one cubic meter of air at 0 deg. C. (32 deg. F.) and 762-mm. pressure = 1.293 kg.

The volume of 1,000 kg. (1 metric ton) of air at 0 deg. C. and 762-mm. pressure

$$= \frac{1}{1.293} \times 1{,}000$$

$$= 773.395 \text{ cu.m.}$$

The volume of 1,000 kg. of air at 20 deg. C. and at 762-mm. pressure =

$$773.395 \text{ cu.m.} \times \frac{273 + 20}{273}$$

$$= 830.054 \text{ cu.m.}$$

The volume of 1,000 kg. of air at 0 deg. C. and at varying altitudes =

$$773.395 \text{ cu.m.} \times \frac{762}{\text{Barometric pressure in millimeters}}$$

$$= \frac{589{,}327}{\text{Barometric pressure in millimeters}}$$

The volume of 1,000 kg. of air at 20 deg. C. and at varying altitudes =

$$\frac{830.054 \text{ cu.m.} \times 762}{\text{Barometric pressure in millimeters}}$$

$$= \frac{632{,}501}{\text{Barometric pressure in millimeters}}$$

Barometric pressures in millimeters of mercury and the volumes of 1 kg. of air at 0 deg. C. and 20 deg. C., for their equivalent altitudes, are to be found in Table II.

Table I—Matte Analyses

Per Cent Cu	Per Cent Fe	Per Cent S
10.0	57.375	27.625
15.0	53.000	27.000
20.0	48.625	26.375
25.0	44.250	25.750
30.0	39.875	25.125
35.0	35.500	24.500
40.0	31.125	23.875
45.0	26.750	23.250
50.0	22.375	22.625
55.0	18.000	22.000
60.0	13.625	21.375

Table II—Barometric Pressures and Volumes of 1 Kg. of Air at 0 Deg. C. and at 20 Deg. C. for Altitudes Up to 3,048 Meters

Altitude				Cu. M. of Air at 0 deg C. of 1 Kg. of Air	Cu. M. of Air at 20 deg. C. of 1 Kg. of Air
Meters	Feet	Mm. Hg.	Inches Hg.		
0.0	0	762.0	30.00	0.773395	0.830053
150.0		748.0		0.787870	0.845589
152.4	500	747.8	29.44	0.788081	0.845815
300.0		734.0		0.802897	0.861717
304.8	1,000	733.6	28.88	0.803335	0.862187
450.0		720.0		0.818509	0.878473
457.2	1,500	719.3	28.32	0.819306	0.879328
600.0		706.9		0.833678	0.894753
609.6	2,000	706.1	27.80	0.834622	0.895766
750.0		693.8		0.849419	0.911647
762.0	2,500	692.7	27.27	0.850768	0.913095
900.0		680.9		0.865511	0.928919
914.4	3,000	679.7	26.76	0.867039	0.930559
1,050.0		668.2		0.881961	0.946574
1,066.8	3,500	666.8	26.25	0.883813	0.948561
1,200.0		655.7		0.898775	0.964619
1,219.2	4,000	654.3	25.76	0.900698	0.966683
1,350.0		643.7		0.915530	0.982602
1,371.6	4,500	641.9	25.27	0.918097	0.985357
1,500.0		631.6		0.933069	1.001426
1,524.0	5,000	629.7	24.79	0.935885	1.004448
1,650.0		619.8		0.950834	1.020492
1,676.4	5,500	617.7	24.32	0.954066	1.023961
1,800.0		608.5		0.968491	1.039442
1,828.8	6,000	606.3	23.87	0.972005	1.043214
1,950.0		597.0		0.987147	1.059465
1,981.2	6,500	594.6	23.41	0.991115	1.063742
2,100.0		585.9		1.005849	1.079537
2,133.6	7,000	583.4	22.97	1.010159	1.084163
2,250.0		575.1		1.024738	1.099810
2,286.0	7,500	572.5	22.54	1.029392	1.104805
2,400.0		564.3		1.044350	1.120859
2,438.4	8,000	561.6	22.11	1.049371	1.126248
2,550.0		554.0		1.063767	1.141698
2,590.8	8,500	551.2	21.70	1.069170	1.147498
2,700.0		543.9		1.083520	1.162899
2,743.2	9,000	541.0	21.30	1.089310	1.169133
2,850.0		533.6		1.104417	1.185346
2,895.6	9,500	530.4	20.88	1.111099	1.192498
3,000.0		523.5	20.61	1.125744	1.208215
3,048.0	10,000	520.4	20.49	1.132450	1.215393

Table III—Cubic Meters of Air Required to Oxidize 1 Metric Ton of Iron and Sulphur at Altitudes Up to 3,048 Meters and at 0 Deg. C. and 20 Deg. C.

Altitude in Meters	0 Deg. C.		20 Deg. C.	
	Per Ton Fe	Per Ton S	Per Ton Fe	Per Ton S
0.0	956.580	3,348.030	1,026.658	3,593.303
150.0	974.483	3,410.692	1,045.874	3,660.558
152.4	974.744	3,411.606	1,046.153	3,661.537
300.0	993.070	3,475.744	1,065.822	3,730.376
304.8	993.611	3,477.640	1,066.403	3,732.411
450.0	1,012.379	3,543.329	1,086.546	3,802.913
457.2	1,013.365	3,546.779	1,087.604	3,806.614
600.0	1,031.141	3,608.995	1,106.682	3,873.389
609.6	1,032.309	3,613.082	1,107.935	3,877.775
750.0	1,050.611	3,677.138	1,127.578	3,946.524
762.0	1,052.279	3,682.978	1,129.369	3,952.792
900.0	1,075.514	3,746.801	1,148.941	4,021.294
914.4	1,072.404	3,753.415	1,150.969	4,028.394
1,050.0	1,090.861	3,818.013	1,170.778	4,097.723
1,066.8	1,093.151	3,826.030	1,173.235	4,106.324
1,200.0	1,111.657	3,890.801	1,193.097	4,175.840
1,219.2	1,114.036	3,899.125	1,195.650	4,184.775
1,350.0	1,132.381	3,963.333	1,215.339	4,253.688
1,371.6	1,135.556	3,974.446	1,218.747	4,265.614
1,500.0	1,154.074	4,039.259	1,238.622	4,335.177
1,524.0	1,157.557	4,051.450	1,242.360	4,348.259
1,650.0	1,176.047	4,116.164	1,262.204	4,417.714
1,676.4	1,180.044	4,130.156	1,266.494	4,432.731
1,800.0	1,197.886	4,192.601	1,285.642	4,499.749
1,828.8	1,202.232	4,207.814	1,290.308	4,516.078
1,950.0	1,220.961	4,273.363	1,310.408	4,586.428
1,981.2	1,225.869	4,290.541	1,315.698	4,604.943
2,100.0	1,244.092	4,354.324	1,335.234	4,673.320
2,133.6	1,249.423	4,372.982	1,340.956	4,693.346
2,250.0	1,267.455	4,436.095	1,360.309	4,761.082
2,286.0	1,273.212	4,456.242	1,366.487	4,782.705
2,400.0	1,291.713	4,520.995	1,386.343	4,852.203
2,438.4	1,297.923	4,542.731	1,393.009	4,875.532
2,550.0	1,315.729	4,605.052	1,412.118	4,942.415
2,590.8	1,322.411	4,628.441	1,419.292	4,967.523
2,700.0	1,340.160	4,690.562	1,438.341	5,034.194
2,743.2	1,347.322	4,715.627	1,446.052	5,061.181
2,850.0	1,366.007	4,781.026	1,466.105	5,131.368
2,895.6	1,374.272	4,809.952	1,474.951	5,162.329
3,000.0	1,392.385	4,873.350	1,494.390	5,230.368
3,048.0	1,400.680	4,902.380	1,503.269	5,261.441

Table IV—Tonnages of Matte Blown and Tonnages of Metal Contained, Tons of Converter Slag Made and Tons of Metal Lost to Slags at Each Interval When Blowing 100 Tons of 10 per Cent Matte, in 5 per Cent Copper Matte Intervals

Tons of Matte	Per Cent of Cu	Tons of Cu Contained in Matte	Tons of Fe Contained in Matte	Tons of S Contained in Matte	Tons of Converter Slag Made	Tons of Matte Prills Lost in Converter Slag	Cu Lost in Prills	Fe Lost in Prills	S Lost in Prills
100.0000	10	10.0000	57.3750	27.6250	.....	.....	.....	.....	.....
58.7121	15	8.8068	31.1170	15.8520	53.0327	7.9546	1.1932	4.2160	2.1477
41.5550	20	8.3110	20.2061	10.9601	22.0364	2.4790	0.4958	1.2054	0.6538
32.1576	25	8.0394	14.2297	8.2806	12.0704	1.0864	0.2716	0.4808	0.2797
26.2267	30	7.8680	10.4579	6.5895	7.6177	0.5713	0.1714	0.2278	0.1435
22.1429	35	7.7500	7.8607	5.4250	5.2455	0.3371	0.1180	0.1197	0.0826
19.1595	40	7.6638	5.9634	4.5743	3.8319	0.2155	0.0862	0.0671	0.0515
16.8847	45	7.5981	4.5166	3.9257	2.9221	0.1460	0.0657	0.0391	0.0339
15.0929	50	7.5463	3.3769	3.4147	2.3018	0.1036	0.0518	0.0232	0.0234
13.6444	55	7.5044	2.4560	3.0018	1.8599	0.0761	0.0419	0.0137	0.0167
12.4498	60	7.4699	1.6963	2.6611	1.5344	0.0575	0.0345	0.0078	0.0123
7.3928	100	7.3928	0.0000	0.0000	3.4260	0.0771	0.0771	0.0000	0.0000

Table V—Tons of Converter Slag Made and Tonnage of Metal Lost When Blowing a Given Tonnage of Matte and of a Given Grade to Blister

Tons of Matte to Blister	Per Cent Cu	Tons of Converter Slag Made	Tons of Matte Lost to Converter Slag	Tons of Cu Lost to the Slag	Tons of Fe Lost to Slag in Matte Prills	Tons S Lost to Slag in Matte Prills
100.0000	10	115.8788	13.1042	2.6072	6.4006	3.4451
58.7121	15	62.8461	5.1496	1.4140	2.1846	1.2974
41.5550	20	40.8097	2.6706	0.9182	0.9792	0.6436
32.1576	25	28.7393	1.5842	0.6466	0.4984	0.3639
26.2267	30	21.1216	1.0129	0.4752	0.2706	0.2204
22.1429	35	15.8761	0.6758	0.3572	0.1509	0.1378
19.1595	40	12.0442	0.4603	0.2710	0.0838	0.0863
16.8847	45	9.1221	0.3143	0.2053	0.0447	0.0524
15.0929	50	6.8203	0.2107	0.1535	0.0215	0.0290
13.6444	55	4.9604	0.1346	0.1116	0.0078	0.0123
12.4498	60	3.4260	0.0771	0.0771	0.0000	0.0000
7.3928	100	0.0000	0.0000	0.0000	0.0000	0.0000

Table VI—Metal Lost and Converter Slag Made, by Calculation From Table V

Tons of Metal Contained in 100 Tons of Matte or %			Tons of Converter Slag Made	Metal Lost to Converter Slag When Raising 100 Tons of a Given Grade of Matte to Blister Copper, Tons				Metal Blown to Completion After Losses to Converter Slag When Raising 100 Tons of a Given Grade of Matte to Blister Copper, Tons			
Cu	Fe	S		Matte	Cu	Fe	S	Matte	Cu	Fe	S
10	57.375	27.625	115.879	13.104	2.607	6.401	3.445	86.896	7.393	50.974	24.180
15	53.000	27.000	107.041	8.771	2.408	3.721	2.210	91.229	12.592	49.279	24.790
20	48.625	26.375	98.206	6.427	2.210	2.356	1.549	93.573	17.790	46.269	24.826
25	44.250	25.750	89.370	4.926	2.011	1.550	1.132	95.074	22.989	42.700	24.618
30	39.875	25.125	80.535	3.862	1.812	1.032	0.840	96.138	28.188	38.843	24.285
35	35.500	24.500	71.698	3.052	1.613	0.681	0.622	96.948	33.387	34.819	23.878
40	31.125	23.875	62.863	2.402	1.414	0.437	0.450	97.598	38.586	30.688	23.425
45	26.750	23.250	54.026	1.861	1.216	0.265	0.310	98.139	43.784	26.485	22.940
50	22.375	22.625	45.189	1.396	1.017	0.142	0.192	98.604	48.983	22.233	22.433
55	18.000	22.000	36.355	0.986	0.818	0.057	0.090	99.014	54.182	17.943	21.910
60	13.625	21.375	27.519	0.619	0.619	0.000	0.000	99.381	59.381	13.625	21.375
100	0.000	0.000	.....	.....	.....	.....	.....	.....	.....	.....	.....

Table VII—Per Cent Copper Recovery and per Cent Fe and S Oxidized When Blowing Matte of Different Grades to Blister Copper

Per Cent Cu in Matte	Per Cent Cu Recovered	Per Cent Fe Oxidized	Per Cent S Oxidized
10	73.928	88.843	87.529
15	83.946	92.979	91.814
20	88.950	95.154	94.127
25	91.956	96.497	95.603
30	93.960	97.412	96.656
35	95.391	98.082	97.461
40	96.465	98.596	98.115
45	97.300	99.009	98.666
50	97.966	99.365	99.151
55	98.512	99.683	99.590
60	98.968	100.000	100.000
100	100.000	.....	.....

The cubic meters of air at different elevations and at 0 deg. C. and 20 deg. C. chemically required to oxidize 1 metric ton of iron and 1 metric ton of sulphur are given in Table III.

Converter Slag Made. Metal Losses and Recoveries—There is considerable loss of copper in the form of unconverted matte prills in the converter slag. Of course, most of this loss is recovered in the reverberatory or settler of the blast furnace, whichever the case may be, and is returned to the converter. However, most plants know the tonnage of matte charged to the converter each day, and it is in these terms that they are interested.

That matte which goes into the converter slag will not require air to oxidize the iron and the sulphur contained.

At a large copper-converting plant, the tonnage of matte charged to the converter, the analysis of the matte charged, the analysis of the converter slag, and the metric tons of copper produced were systematically kept, and a permanent record was made over a period of years.

The average analysis of the converter slag at this plant was: 2.25 per cent Cu, 24.3 per cent SiO_2, 63.7 per cent FeO (49.513 per cent Fe), 1.9 per cent CaO, 3.23 per cent S, 3.1 per cent Al_2O_3, and 0.9 per cent MgO. Assuming that the SiO_2, CaO, and Al_2O_3 come from the converter flux, and the other ingredients come from the converting of matte, we arrive at an effective flux that would analyze 82.935 per cent SiO_2, 6.485 per cent CaO, and 10.58 per cent Al_2O_3. The usual converter flux analyzes about 65 per cent SiO_2, but these fluxes usually contain some iron, which will, in itself, consume silica; also, it must be realized that the usual analysis does not add up to 100 per cent. The above calculated analysis is the effective flux, and therefore allowances must be made when considering actual fluxes.

When converting copper mattes to blister copper, the operation is done by fractional blows; that is, five or six pots of matte are charged with flux and blown for an hour or more; then the slag is skimmed and new matte and flux are charged and blown; and so on, until a sufficient amount of whilte metal is in the converter to justify the finishing of the charge.

Each pot of converter slag contains a certain amount of matte prills that are probably of the same grade of matte as the residual matte in the converter at that point of the blow. The loss of the matte prills into the converter slag means loss of copper, iron, and sulphur from the charge.

Method of Calculations—In the following calculations we will use the analysis given for the converter slag, as a basis, to determine the progress of the blow, to establish the losses, and find the metric tons of converter slag produced when blowing 100 metric tons of 10 per cent copper matte to blister copper, through intervals of 5 per cent increase in copper matte for each step.

To start with, 100 metric tons of 10 per cent copper matte (Table I) contains 57.375 metric tons Fe, 27.625 tons S, and 10 tons of Cu. We blow to 15 per cent copper matte, and then there will be in the converter, before skimming, 66.6667 metric tons of matte and actual slag. From the analysis of a 15 per cent matte, this tonnage of matte will contain: 35.3333 tons Fe, 18.000 tons S, and 10 tons of Cu. But, as we had 57.375 tons of Fe to start with, 57.375 tons Fe minus 35.3333 tons Fe = 22.042 tons Fe, which is oxidized and goes to actual slag. But the actual slag will have matte prills of 15 per cent grade entangled in it. This we will call converter slag.

At this point, 100 kg. of converter slag will have 2.25 kg. of copper in it, contained in the form of 15 per cent copper matte prills; then,

$$\frac{2.25 \text{ kg. of copper} \times 100}{15} = 15 \text{ kg.}$$

of matte, or 15 per cent of the converter slag will be matte prills; the other 85 per cent of the converter slag will be actual slag.

In a 15 per cent copper matte there is 53 per cent Fe.

Let Y = Weight of converter slag after blowing 100 tons of 10 per cent matte to 15 per cent matte.

Then Y = Matte prills + actual slag.

15 per cent Y = Weight of matte prills and 53 per cent $\times$ 15 per cent Y = Fe in matte prills.

The converter slag has 63.7 per cent FeO, or 49.513 per cent Fe.

$0.49513\ Y = 0.53 \times 0.15Y + 22.042$

$Y = 53.0327$ tons of converter slag.

Then 53.0327×49.513 per cent = 26.258 tons total Fe in converter slag — 22,042 tons Fe in actual slag = 4,216 tons Fe in prills.

53.0327×2.25 per cent = 1.1932 tons of copper in converter slag.

$\frac{1.1932 \times 100}{15} = 7.9546$ tons = Weight of matte prills.

Therefore, after skimming the slag, we will have in the converter: 66.6667 tons of matte, less 7.9546 tons, or 58.7121 tons; 35.333 tons of Fe, less 4.216 tons, or 31.117 tons; 18.000 tons of S, less 2.148 tons, or 15.852 tons; and 10.000 tons of Cu, less 1.1932 tons, or 8.8068 tons.

Our next step is to blow from 15 per cent copper matte to 20 per cent copper matte. The method of calculating this step, as well as each succeeding step, is the same as that just given, but space precludes recording all of these calculations in this article.

The results of these calculations for 100 tons of 10 per cent matte blown to blister copper at intervals of 5 per cent copper matte are tabulated in Table IV.

By cumulative additions of the converter-slag figures and metal losses from Table IV, we arrive at the amount of converter slag and the metal losses for any grade of matte blown in the 5 per cent intervals, for a given amount of matte converted. This is shown in Table V.

Table VI was derived from Table V. The amount of metal losses and converter slag made were calculated on the basis of 100 tons of each grade of matte to be converted.

From the tons of the metal lost and the tons of the metals contained in the matte charged to the converter, we arrive at the tons of copper recovered and the tons of iron and sulphur blown to completion. See Table VII.

Basic Factors Used in Calculating Capacities on a 13x30-Ft. Peirce-Smith Converter—The Size of Charge—The converter is to make 65 tons of copper per charge, regardless of the grade of matte used. This is the usual charge in several American plants having this type of converter.

The Quantity of Air Used in the Converter—Many of the converters in American plants were installed some years ago, and the air was supplied by reciprocating blowing engines. In many cases, particularly those plants operating at sea level, the blowing engines were operated at a piston displacement of 20,000 cu.ft. of free air

Table VIII—Reciprocating Blower Requirements at Various Altitudes for a 13x30-Ft. Peirce-Smith Converter

		Air Volumes Per Minute					
		Air at 14 Lb. Gage		Free Air Vol. at 0 Deg. C.			
Meters Altitude	Barometer in Mm. Hg.	Vol. Cu.ft. Delivered	Temp., Deg. C.	Delivered, Cu.Ft.	Piston Displacement, Cu.Ft.	Chemically Used Cu.Ft.	Chemically Used Cu.M.
0	762.0	11,180.46	65.20	17,600.0	20,000.0	12,120.0	343.202
150	748.0	11,180.46	66.23	17,708.1	20,122.8	12,194.5	345.312
300	734.0	11,180.46	67.07	17,828.5	20,259.7	12,277.4	347.659
450	720.0	11,180.46	68.25	17,938.8	20,385.0	12,353.4	349.811
600	706.9	11,180.46	69.24	18,052.7	20,514.4	12,431.8	352.031
750	693.8	11,180.46	70.27	18,170.5	20,648.2	12,512.9	354.328
900	680.9	11,180.46	71.35	18,288.8	20,782.7	12,594.4	356.636
1,050	668.2	11,180.46	72.38	18,412.8	20,923.7	12,679.8	359.054
1,200	655.7	11,180.46	73.43	18,539.0	21,067.0	12,766.7	361.515
1,350	643.7	11,180.46	74.52	18,661.6	21,206.4	12,851.1	363.905
1,500	631.6	11,180.46	75.63	18,790.9	21,353.2	12,940.2	366.428
1,650	619.8	11,180.46	76.75	18,921.2	21,501.3	13,029.9	368.968
1,800	608.5	11,180.46	77.87	19,049.5	21,647.1	13,118.2	371.468
1,950	597.0	11,180.46	79.05	19,184.3	21,800.4	13,211.1	374.099
2,100	585.9	11,180.46	80.19	19,321.0	21,955.6	13,305.2	376.763
2,250	575.1	11,180.46	81.34	19,458.1	22,111.5	13,399.6	379.436
2,400	564.3	11,180.46	82.55	19,598.7	22,271.0	13,496.4	382.178
2,550	554.0	11,180.46	83.70	19,739.7	22,431.5	13,593.5	384.927
2,700	543.9	11,180.46	84.85	19,883.2	22,594.6	13,692.4	387.728
2,850	533.6	11,180.46	86.12	20,031.3	22,762.9	13,794.4	390.616
3,000	523.5	11,180.46	87.39	20,182.4	22,934.5	13,898.4	393.561

Table IX—Operating Data for Producing a Charge of 65 Tons of Copper in a 13x30-Ft. Peirce-Smith Converter From Varying Grades of Matte

PerCent Cu in Matte	Tons of Matte Charged	Tons of Iron Blown or Oxidized	Tons of S Blown or Oxidized	Tons of Converter Slag Made	Ladles of Converter Matte	Ladles of Converter Slag	Ladles of Converter Cu	Time Not Blowing, Minutes
10	879.210	448.169	212.593	1,018.820	80.7	175.2	8.1	976.5
15	516.200	254.378	127.966	552.546	47.4	95.0	8.1	575.5
20	365.374	169.055	90.708	358.819	33.5	61.7	8.1	409.0
25	282.744	120.732	69.606	252.688	26.0	43.4	8.1	317.5
30	230.595	89.843	56.000	185.710	21.2	31.9	8.1	260.0
35	194.686	67.788	46.481	139.586	17.9	24.0	8.1	220.5
40	168.455	51.695	39.461	105.896	15.5	18.2	8.1	191.5
45	148.456	39.319	34.056	80.205	13.6	13.8	8.1	169.5
50	132.699	29.503	29.768	59.965	12.2	10.3	8.1	152.0
55	119.966	21.525	26.285	43.614	11.0	7.5	8.1	138.0
60	109.463	14.914	23.398	30.123	10.0	5.2	8.1	126.5
100	100.000	.....	.....	.....	....	....	...	.....

Table X—100 Cubic Meters of Air at 0 Deg. C. Chemically Required to Oxidize the Iron and Sulphur in the Matte Charged to the Converter in Order to Produce 65 Tons of Copper

Altitude in Meters	Grade of Matte, per Cent Copper 10	15	20	25	30	35	40	45	50	55	60
0	11,405	6,718	4,654	3,485	2,734	2,205	1,816	1,516	1,279	1,086	926
150	11,618	6,843	4,741	3,551	2,785	2,246	1,850	1,545	1,303	1,106	943
300	11,840	6,974	4,832	3,618	2,839	2,289	1,885	1,574	1,328	1,127	961
450	12,070	7,110	4,926	3,689	2,894	2,333	1,922	1,605	1,353	1,149	980
600	12,294	7,241	5,017	3,757	2,947	2,376	1,957	1,635	1,379	1,171	998
750	12,526	7,378	5,112	3,828	3,003	2,421	1,994	1,665	1,405	1,193	1,017
900	12,786	7,531	5,217	3,906	3,064	2,471	2,035	1,699	1,433	1,216	1,037
1,050	13,006	7,661	5,307	3,975	3,118	2,514	2,071	1,729	1,458	1,238	1,056
1,200	13,254	7,807	5,409	4,050	3,178	2,562	2,110	1,762	1,486	1,262	1,076
1,350	13,501	7,952	5,509	4,126	3,237	2,610	2,149	1,795	1,514	1,286	1,096
1,500	13,759	8,105	5,615	4,205	3,299	2,660	2,191	1,829	1,543	1,310	1,117
1,650	14,021	8,259	5,722	4,285	3,362	2,710	2,232	1,864	1,572	1,335	1,139
1,800	14,282	8,412	5,828	4,365	3,424	2,761	2,274	1,899	1,601	1,360	1,160
1,950	14,557	8,574	5,940	4,449	3,490	2,814	2,317	1,935	1,632	1,386	1,182
2,100	14,833	8,737	6,053	4,533	3,556	2,867	2,361	1,972	1,663	1,412	1,204
2,250	15,111	8,901	6,167	4,618	3,623	2,921	2,406	2,009	1,694	1,439	1,227
2,400	15,400	9,071	6,285	4,706	3,692	2,977	2,452	2,048	1,727	1,466	1,250
2,550	15,687	9,240	6,401	4,794	3,761	3,032	2,497	2,086	1,759	1,494	1,274
2,700	15,978	9,411	6,520	4,883	3,831	3,089	2,544	2,124	1,792	1,521	1,297
2,850	16,286	9,593	6,646	4,977	3,905	3,148	2,593	2,165	1,826	1,551	1,322
3,000	16,601	9,778	6,774	5,073	3,980	3,209	2,643	2,207	1,862	1,581	1,348

Table XI—Metric Tons of Matte Charged Daily to a 13x30-Ft. Peirce-Smith Converter

Altitude in Meters	Grade of Matte, per Cent Copper 10	15	20	25	30	35	40	45	50	55	60
0	294.4	293.5	298.1	305.2	314.1	324.9	336.4	349.3	364.0	380.5	397.0
150	291.6	290.6	295.3	302.5	311.2	321.9	333.2	346.5	361.2	377.2	394.1
300	288.9	287.9	292.5	299.6	308.6	318.9	330.5	343.1	357.8	373.9	390.2
450	286.0	285.0	289.6	296.8	305.5	315.7	327.4	339.9	354.5	369.9	387.3
600	283.3	282.3	286.9	294.0	302.7	312.9	324.3	337.2	351.3	366.8	383.5
750	280.6	279.7	284.1	291.2	299.7	310.1	321.3	334.0	348.7	363.7	380.7
900	277.5	276.5	281.1	288.1	296.8	306.7	318.3	330.9	344.9	360.7	377.1
1,050	275.3	274.3	278.8	285.7	294.4	304.4	315.4	327.9	342.4	357.7	374.4
1,200	272.7	271.8	276.2	283.1	291.5	301.5	312.6	325.4	339.4	354.7	370.9
1,350	270.1	269.2	273.6	280.4	289.0	298.9	309.8	322.4	336.4	351.8	368.3
1,500	267.6	266.6	271.1	277.7	286.3	296.0	307.1	319.6	333.5	348.3	364.9
1,650	265.0	264.2	268.4	275.3	283.6	293.3	304.4	316.7	330.6	345.5	361.5
1,800	262.6	261.6	266.0	272.7	280.9	290.8	301.7	313.9	327.8	342.8	359.1
1,950	260.1	259.2	263.5	270.2	278.3	288.1	299.1	311.2	325.0	339.4	355.8
2,100	257.6	256.8	261.0	267.7	275.8	285.5	296.2	308.5	322.2	336.7	352.6
2,250	255.3	254.4	258.7	265.2	273.3	282.9	293.7	305.8	319.0	334.1	350.3
2,400	252.9	252.0	256.3	262.8	270.9	280.3	290.9	302.8	316.4	330.9	347.2
2,550	250.6	249.8	253.9	260.5	268.4	277.9	288.4	300.3	313.8	328.4	344.2
2,700	248.3	247.5	251.6	258.2	266.1	275.4	286.1	297.7	311.2	325.9	341.2
2,850	246.0	245.2	249.4	255.7	263.5	273.0	283.4	295.3	308.2	322.9	338.3
3,000	243.7	242.8	247.0	253.4	261.3	270.6	280.8	292.4	305.7	319.9	336.1

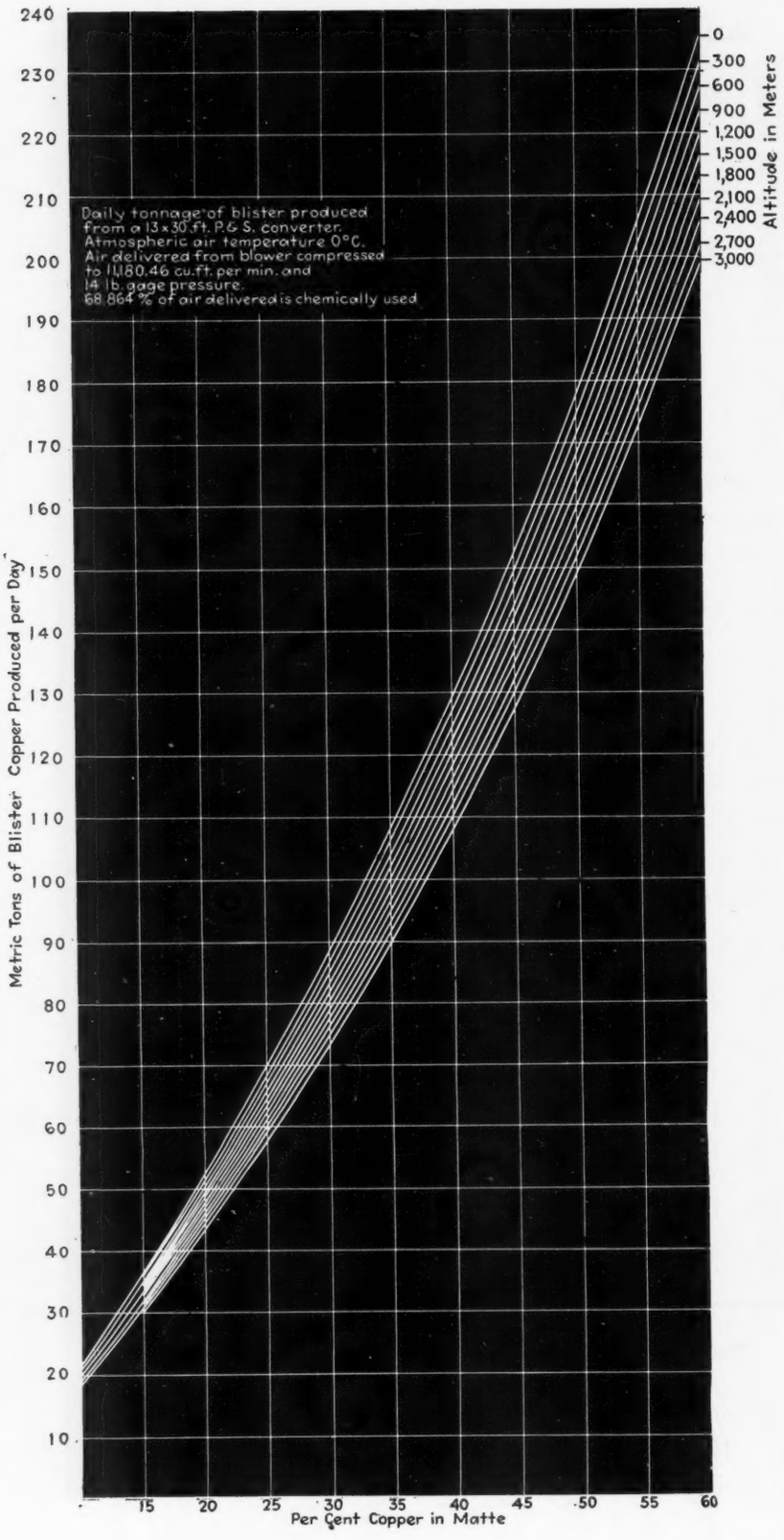


Fig. 1—CURVES SHOWING DAILY TONNAGE OF BLISTER COPPER

produced by a 13x30-ft. Peirce-Smith converter for any grade of matte up to 60 per cent copper and for any altitude up to 3,000 meters

per minute for one 13x30-ft. Peirce-Smith converter and at a pressure of 13 to 14 lb. per square inch at the converter; higher pressures than this were found impractical, as the "slop" from the converter throat became excessive.

The 20,000-cu.ft. piston displacement does not represent the air that the copper converter uses chemically, as a great deal of the air is not realized, due to the inefficiencies of the blowing engine and to air wasted. The loss at the blower, due to slippage, is considerable. The assumption used herein is 88 per cent volume efficiency, as this was given by the Ingersoll-Rand engineers. Other losses are the line losses between the power house and the converter valve; loss through the revolving slip joint at the converter; loss in the tuyere box and through the tuyere valves; loss through the tuyere valves during punching; loss inside the converter from oxygen not consumed for oxidation, this being principally air lost when the converter is being turned up or down, with air on, while the tuyeres are not under metal bath; and loss of air through the lining.

The air not lost is effectively used for oxidation. A survey of the air used at various American smelters showed that the piston displacement is from 135 to 182 per cent of the theoretical amount of air needed. In these calculations the round figure of 165 per cent of the air needed chemically has been taken as a good safe figure for the piston displacement. In other words, a basic assumption for air required was: At sea level and at 0 deg. C., a reciprocating blowing engine will be required to operate at the rate of 20,000 cu.ft. per minute free air displacement; at 88 per cent efficiency, 17,600 cu.ft. will be delivered. Of the 20,000 cu.ft., 60.6 per cent will be used chemically, or 12,120 cu.ft., which is 68.864 per cent of the air delivered.

The air delivered is compressed to 14-lb. gage pressure at the converter. From a formula given to me by Mr. Church, of the Ingersoll-Rand Company, the 17,600 cu.ft. of free air at 0 deg. C., when compressed to 14-lb. pressure, will have a volume of 11,180.46 cu.ft. and a temperature of 65.2 deg. C. So, a further basic assumption was used, that the air delivered by the compressor to the converter will be 11,180.46 cu.ft. at 14-lb. gage, at all altitudes. On this basis, and using the formula mentioned, the blower requirements, at various altitudes, were determined, as given in Table VIII

Time Not Blowing—Thirty minutes will be assumed as the time required to charge the converter at the start, for each charge of 65 tons of copper. Five minutes will be allowed to skim each pot of slag and to pour the ladles of matte standing ready. Five minutes will be allowed to pour each pot of copper. It is further assumed that

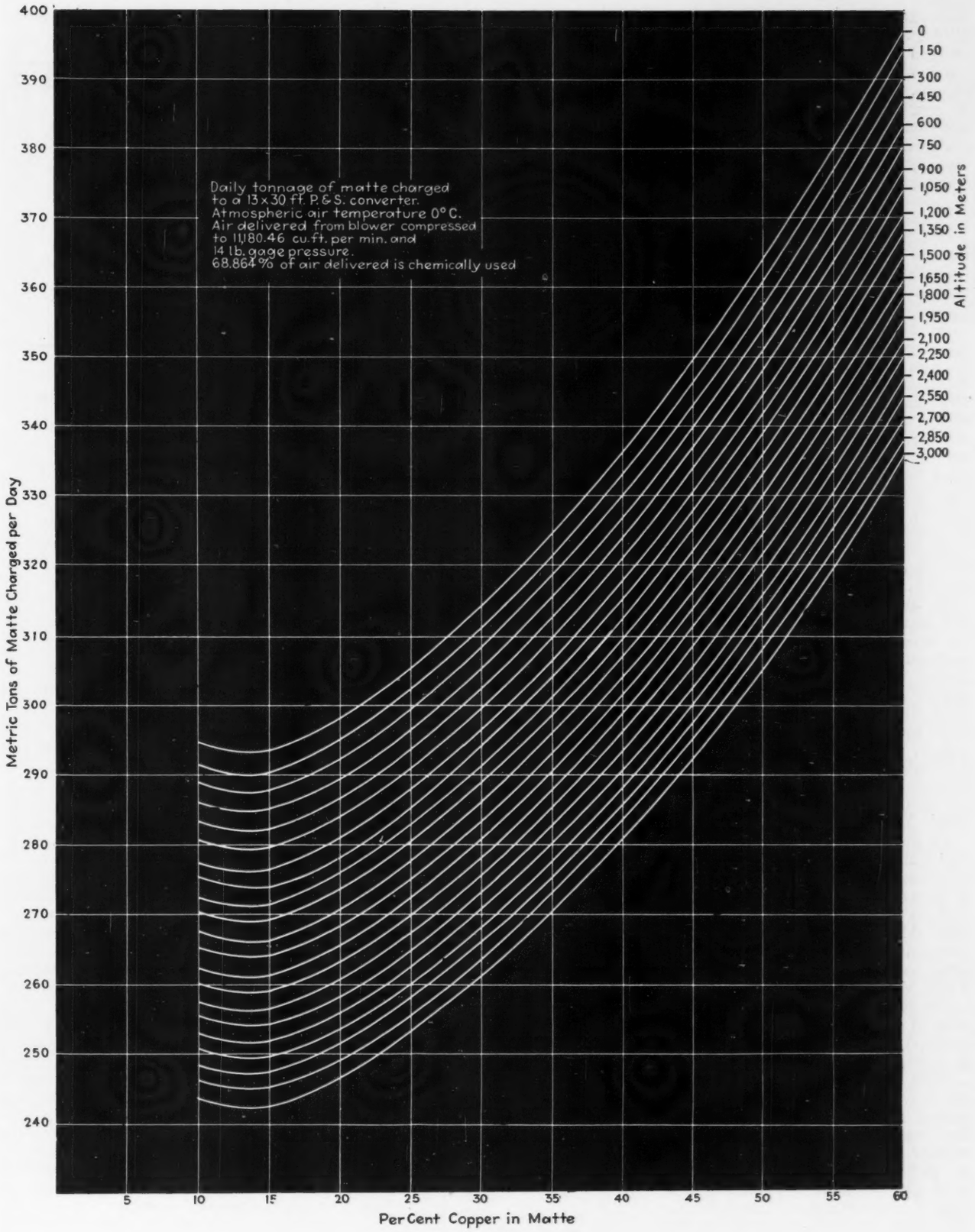


Fig. 2—CURVES SHOWING THE DAILY TONNAGE OF MATTE

containing up to 60 per cent copper that can be charged in a 13x30-ft. Peirce-Smith converter at any altitude up to 3,000 meters

there is a holding furnace for the blister, so that casting time is not charged against the converter. Thirty minutes will be allowed for pulling mouths, cleaning hoods, punching tuyeres, and claying up for each charge of 65 tons of copper.

Capacity of Pots—The pots used are assumed to have a capacity of 120 cu.ft. They will hold on the average: Matte, 12 short tons, or 10.889 metric tons; converter slag, 6.41 short tons, or 5.816 metric tons; and copper, 8.74 short tons, or 7.940 metric tons.

In Table IX will be found the tabulation of operating data for producing a charge of 65 tons of copper, using the basic assumptions just given. This table gives the tons of matte charged, the tons of iron and sulphur to be oxidized, the tons of effective converter slag made, the ladles of matte, converter slag, and copper, and the time not blowing, or auxiliary time, necessary for each charge. These are tabulated for each grade of matte after taking into consideration the amount of copper, iron, and sulphur lost, shown in Table VI.

We have in Table III the cubic meters of air required to oxidize one ton of iron and one ton of sulphur when atmospheric air is at 0 deg. C. and at various altitudes. In Table IX we have the tons of iron and sulphur required to be oxidized, for various grades of matte, when producing a charge of 65 tons of copper. From these, the cubic meters of air chemically required to produce 65 tons of copper, for varying grades of matte, was calculated, with plants located at various altitudes and with atmospheric air at 0 deg. C. This is shown in Table X.

As we know the cubic meters of air chemically required at any altitude, for all grades of matte, for a 65-ton charge of copper (Table X), we may find the minutes of actual blowing time to produce this charge by dividing by the cubic meters of air which are chemically used per minute, as found in Table VIII.

The total time of charge will be the sum of the minutes blowing and the auxiliary, or lost time, per charge, found in Table IX.

With this time known, the charges per day, or 1,440 minutes, may be obtained. The tons of matte charged per day was found by multiplying the number of charges per day by the tons of matte needed to produce a charge of 65 tons of copper in Table IX. The tons of blister copper produced per day was found by multiplying the number of charges per day by 65 tons.

These daily tonnages of matte charged and blister produced, for any grade of matte and at any altitude, are shown in the graphs, Fig. 1 and Fig. 2, and in Tables XI and XII, from which the two graphs were plotted.

The original purpose of these calculations was only to arrive at approximate figures to serve as a guide, and as such they are presented here. The choice of the factors assumed that would fit the many cases was the difficult task. However, the final results check closely with five different plants.

Table XII—Metric Tons of Blister Copper Produced Daily From a 13x30-Ft. Peirce-Smith Converter

Altitude in Meters	Grade of Matte, per Cent Copper										
	10	15	20	25	30	35	40	45	50	55	60
0	21.8	37.0	53.0	70.2	88.6	108.5	129.8	152.9	178.3	206.2	235.8
150	21.6	36.6	52.5	69.5	87.7	107.5	128.6	151.7	176.9	204.4	234.0
300	21.4	36.3	52.0	68.9	87.0	106.5	127.5	150.2	175.3	202.6	231.7
450	21.1	35.9	51.5	68.2	86.1	105.4	126.3	148.8	173.7	200.4	230.0
600	20.9	35.5	51.0	67.6	85.3	104.5	125.1	147.6	172.1	198.7	227.7
750	20.7	35.2	50.5	67.0	84.5	103.5	124.0	146.3	170.8	197.1	226.1
900	20.5	34.8	50.0	66.2	83.6	102.4	122.8	144.9	169.0	195.4	223.9
1,050	20.4	34.5	49.6	65.7	83.0	101.6	121.7	143.6	167.7	193.8	222.3
1,200	20.2	34.2	49.1	65.1	82.2	100.6	120.6	142.5	166.3	192.2	220.2
1,350	20.0	33.9	48.7	64.5	81.5	99.8	119.5	141.2	164.8	190.6	218.7
1,500	19.8	33.6	48.2	63.8	80.7	98.8	118.5	139.9	163.4	188.7	216.7
1,650	19.6	33.3	47.8	63.3	79.9	97.9	117.4	138.7	161.9	187.2	214.7
1,800	19.4	32.9	47.3	62.7	79.2	97.1	116.4	137.4	160.6	185.7	213.2
1,950	19.2	32.6	46.9	62.1	78.5	96.2	115.4	136.3	159.2	183.9	211.3
2,100	19.0	32.3	46.4	61.5	77.7	95.3	114.3	135.1	157.8	182.5	209.4
2,250	18.9	32.0	46.0	61.0	77.0	94.5	113.3	133.9	156.3	181.0	208.0
2,400	18.7	31.7	45.6	60.4	76.3	93.6	112.2	132.6	155.0	179.3	206.2
2,550	18.5	31.5	45.2	59.9	75.7	92.8	111.3	131.5	153.7	177.9	204.4
2,700	18.4	31.2	44.8	59.4	75.0	91.9	110.4	130.4	152.4	176.6	202.6
2,850	18.2	30.9	44.4	58.8	74.3	91.1	109.3	129.3	151.0	175.0	200.9
3,000	18.0	30.6	43.9	58.2	73.6	90.3	108.3	128.0	149.8	173.3	199.6

Application

This report may be helpful in a number of ways. If a new smelter is being considered, in any location, and the tonnage and grade of matte are known, then, from the foregoing, the number of 13x30-ft. Peirce-Smith converters needed can be chosen and the air required can easily be determined.

For an operating plant having this type of converter, its daily work may be checked. The individual factors that go to make up the final result of the work may be compared with the factors in these calculations, and thus suggest a line of thought which may lead to improvement.

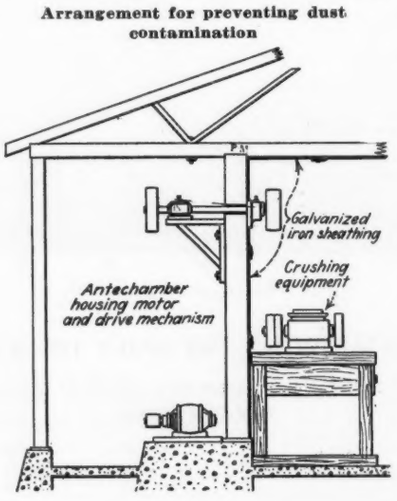
A company having several converter plants, in various locations, and operating on different grades of matte, may, with these graphs, have a basis for comparing one plant with another.

I have also prepared similar capacity charts for the tonnage smelted daily in reverberatories, with varying amounts of fuel fired; with the further condition of different temperatures if the charge is hot, and varying moistures if the charge is wet. Calculations based on roaster data are also contemplated. Then, if detailed costs are known, the best method of operating each of the three departments, to obtain the greatest economy for the smelter charge as a whole, may be determined.

Novel Sampling Plant Construction

PREVENTION of contamination of samples by dust in the sampling plant has always been a problem to the mill superintendent. At the average mine, the building housing the sampling room is of wood construction, and usually without facilities to remove accumulated dust frequently and rapidly. In consequence, a certain quantity of dust will enter the prepared sample, despite extra care on the part of the operator, and incorrect assays result.

Arrangement for preventing dust contamination



Bearing this in mind, the Beebe Gold Mining Company, at Georgetown, Calif., employed the novel features illustrated in the accompanying sketch in the construction of the new sampling plant placed in operation recently. As will be seen, the building is a wood-frame structure containing the sampling room proper, and an adjoining antechamber in which are installed the motors and transmission equipment driving the crushers and disk grinders. The walls and the roof of the sampling room are carefully covered with galvanized-iron sheathing, and the floor is of concrete, with drainage openings at suitable points. This permits frequent washing of the room with a water hose after removal of the rubber drive belts, tools, and prepared samples. Tight-fitting doors and the special bearings supporting the end of the transmission shaft projecting into the sampling room prevent dust and wash water from entering the antechamber.

From Gunpowder to Modern Dynamite

Known for 700 years, explosives have served the mining industry for less than half that time

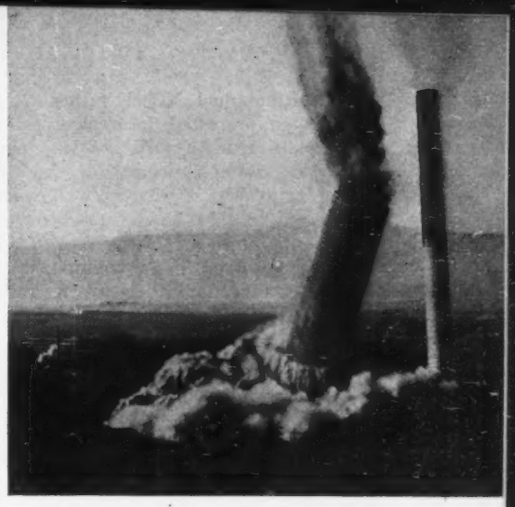
H. C. Chellson
Assistant Editor

WHEN Kaspar Weindl officially set off the first blast of gunpowder for mining purposes in Schemnitz, Hungary, on Feb. 8, 1627, little did he think that Central Europe today would be described as a powder box, or that chemical engineering would have produced so many kinds of explosives for the mining industry.

The name of the first maker of gunpowder is not known. Some believe the inventor to have been a monk by the name of Berthold Schwarz, but no records are available confirming this. Many believe that the Chinese, Hindoos, and Arabians were the first makers of gunpowder, but this is merely guesswork. The first facts about gunpowder were known in 1242, as the investigation by Lieutenant Colonel H. W. L. Hime determined that Roger Bacon's works contained instructions for the refining of saltpeter and the preparation of gunpowder. This interesting subject inspired great curiosity and consequent research in those early times as gunpowder became better known from 1310 to 1320 for use in firearms. Such was its limitation for three centuries, and not until 1622 was gunpowder mentioned in connection with any underground excavation.

In the "Bergwerckschatz" of Elias Montanus (Frankfort) there is a description of a copper ball filled with gunpowder. The outside was covered with cotton soaked with saltpeter and dipped into a mixture of pitch and sulphur. There was a small hole in the ball, through which was placed a quill. A flame was projected through the small quill and the complete unit thrown into the shaft or tunnel to drive out the accumulated smoke. This same device is also reported used as an advance guard or scout when going through old tunnels. The ball would be thrown into the old drift, and if no loose rocks fell after the explosion it was considered safe to advance. This may have been the birth of the idea to use gunpowder in the cracks and crevasses in the rocks, since it had the property to bring down loose rock. Five years later, it is recorded that Kaspar Weindl officially set off the first blast of gunpowder for mining purposes. The practice spread to Bohemia and to the Harz. Gunpowder was thought to have been introduced in England by Germans in 1670 and reached the Cornwall tin mines nineteen years later. About 1724 it reached Sweden, but gunpowder was not used in the Aussee salt mines until forty years later.

Because all rocks did not have convenient cracks in which to place gunpowder, some practical scheme had to be devised to make openings in the rocks. The "rock drill" solved this difficulty, and crude drilling was developed by Hemming Hutman in 1683. Two years later tamping with clay was started, and in 1689 cartridge cases made of paper replaced those of leather. During these years drilling technique was studied, and finally, in 1717, small holes were drilled into the rock. Progress advanced, and chisel bits were the style used thirty years later.

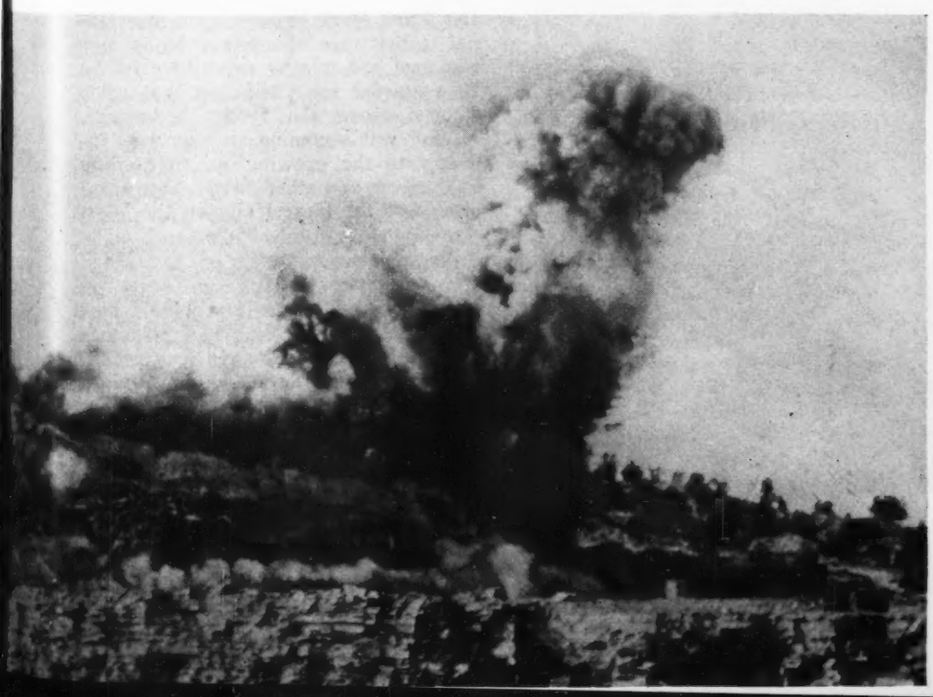


EXPLOSIVE ENGINEERING helped determine the exact direction of fall of this old smelter stack in Garfield, Utah. The explosion of 35 lb. of dynamite under timber wedges was all that was required to drop the 6,000-ton mass

Various and sundry designs of drilling equipment followed, but gunpowder remained unchanged. The manufacture of fuse was the next step, and in 1831 William Bickford invented safety fuse in England. Rock drilling took another step forward in 1854, when Brunton and Bartlett first used compressed air. Gunpowder, however, remained unchanged for 227 years, but the potential possibilities of this simple explosive, consisting of 75 per cent saltpeter, 10 per cent sulphur, and 5 per cent charcoal, received more attention, and from 1845 up to 1900 revolutionary progress in explosives was evident. Since that time to the present explosives have been studied in the chemical laboratory and examined under the microscope, with satisfactory results. Chemists generally agree, however, that much can still be learned in explosives manufacture.

The composition of black powder has undergone little change for many years. There has been substitution of sodium nitrate for potassium nitrate blasting powders in this country. Around 1898 nitrocellulose smokeless powders replaced black powder for military purposes. Although dynamites have in many instances replaced black powder, and thus curtailed its production, it is still used extensively.

Professors of chemistry in Europe played and experimented with gunpowder for many years, but reported no practical progress. Ascanio Sobrero, of Turin, Italy, discovered nitroglycerin. He probably considered its possibilities too dangerous and prescribed it for medicinal purposes, especially for angina pectoris. Some chemists carried on where Sobrero left off, but results were disas-



trous. Emmanuel Nobel, father of Alfred, was interested in explosives, but principally from a military standpoint. Following the Crimean War the elder Nobel returned to Stockholm, Sweden, where he built a small laboratory for the manufacture of nitroglycerin. Alfred, the son, was not a chemist, but he realized the possibilities to the industrial world if nitroglycerin could be tamed. He experimented, but disastrous results occurred in various parts of the world when his manufactured product exploded prematurely. He persisted, however, and after a chemist, George M. Mowbray, of Massachusetts, had determined the method of purifying nitroglycerin, Nobel carried on to his next step. This was to transpose liquid nitroglycerin into a solid form, thereby making it safer. He finally devised a method of using fine diatomaceous earth known as kieselguhr, and mixing it with nitroglycerin he made a paste which was less likely to explode, due to withstanding jolts, and called his product dynamite. His next problem was to set off the dynamite. This he attempted with gunpowder, but not until he experimented further and devised a tube containing fulminate of mercury did he hit on the method of exploding the dynamite. This was achieved in 1864, and from then up to the present chemistry has played the important rôle in the development of explosives in the United States.

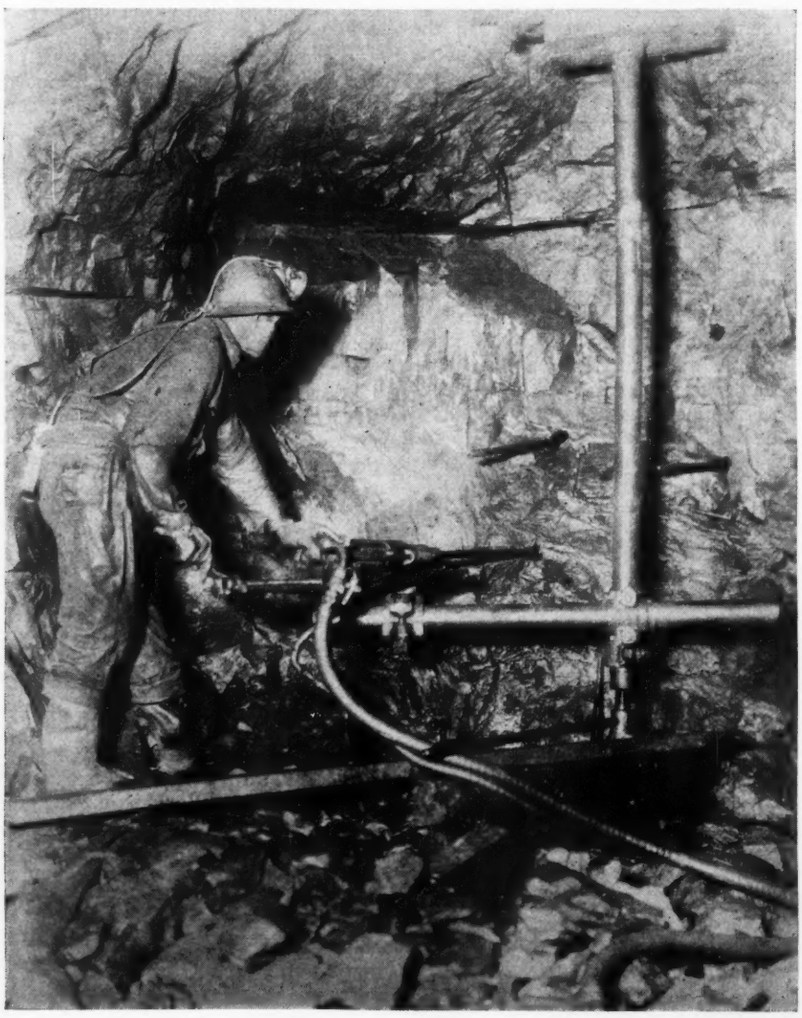
In 1642 (only fifteen years after Kaspar Weindl's blast), John Winthrop, first Governor of Connecticut, ordered the production of materials necessary for the manufacture of gunpowder. Connecticut was the first State in the Colonies to become interested in metal mining. This was due to the discovery of a copper deposit at Simsbury in 1705. A gunpowder plant near the mines helped considerably in the development of these mines. The operating company, the first of its kind in America, was known as the Simsbury Copper Mines, and there were 64 stockholders participating in the enterprise in accordance with the size of their taxable estates in the immediate community.[1]

The English Parliament passed a law prohibiting the mining and smelting of copper in the American Colonies. Mining activities continued, however, hostility against British laws increased, and black powder was made in larger quantities. Iron mining was developing into a new industry, and the records indicate activity in this field. Following the Revolutionary War, immigration to the West grew and industrial development broadened, as iron and copper mining increased. During this early industrial expansion the technique in making explosives improved very little, but the first fulminate of mercury is reported made by E. C. Howard, in 1799. Five years following this E. I. du Pont de Nemours produced the first black powder from his factory. Lammot du Pont was interested in the chemistry of explosives about the same time as Emmanuel Nobel.

Coal mines were being developed, but not until 1818 was the first blast of powder recorded, shot by John Flannigan for Smith Bros. at Plymouth, Pa. Demand for black powder increased along with railroad building about 1830. Many accidents occurred in the use of black powder, and one of the first steps to minimize the hazard was the safety fuse patented by William Bickford, of Tuckingmill, Cornwall, England, to which reference was made in a preceding paragraph. Richard Bacon, superintendent of the copper mines in Simsbury, in Connecticut, heard of the safety fuse, and in 1836 he entered into negotiations with the British manufacturers. As a result he formed a corporation bearing the name Bacon, Bickford, Eales & Company, and the first safety fuse was made in this country in January, 1837. A measure of safety had been gained by the use of black powder spread along a center thread of yarn, during the spinning process, thereby producing a fuse. Experiments with the fuse were made in the copper mines, and results were satisfactory.

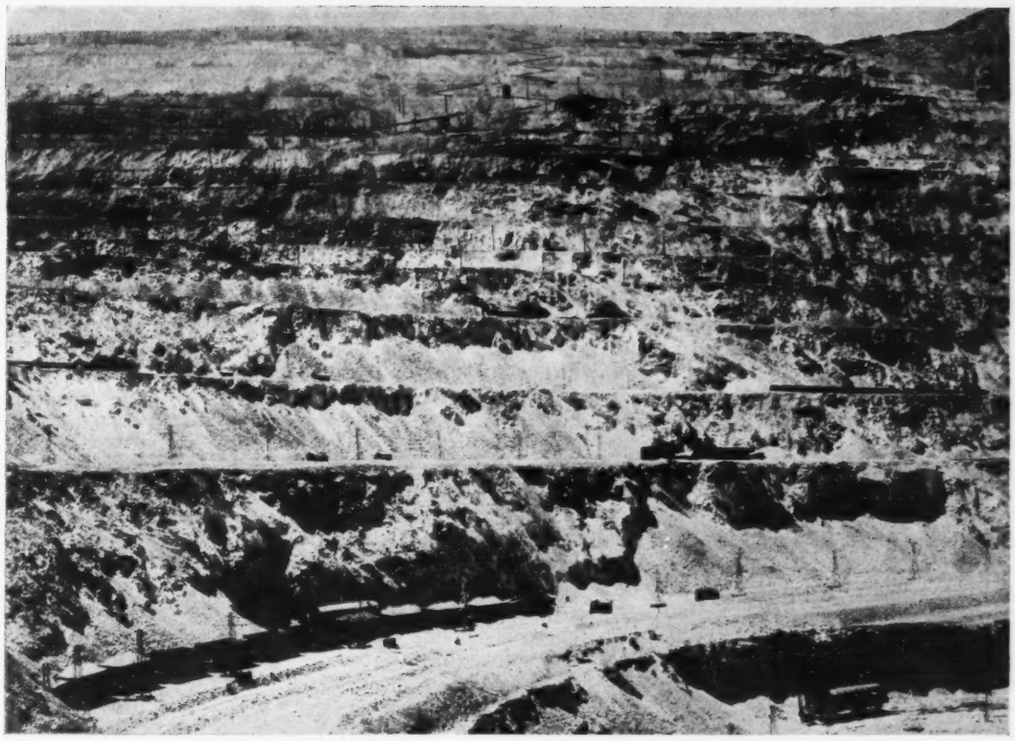
The great iron mines along Lake Superior were discovered about 1840, but not until four years later was the size of the deposits known. Iron-mining activities broadened, and with the news of gold in California in 1849, migration westward increased. Little was known of gold placer mining in the East, and powder salesmen were keenly disappointed when they reached California and found black powder was not essential to that type of mining. Many men who had had mining experience in the East started for California, but some stopped along the Rocky Mountains. Mining was becoming an important industry to the growing nation needing gold, silver, and other metals. San Francisco was the largest city on the West

[1]History of Simsbury 1642-1935. J. E. Ellsworth.



PREPARING FOR THE BLAST

The metal miner advances through rock by means of small holes and dynamite. The ignition and detonation of the solid dynamite creates instantaneous gases of great volume which shatter the surrounding rock and the miner has "shot his round"



BLACK POWDER, DYNAMITE CAP AND FUSE

have torn millions of tons of ore from surface workings of large iron and copper mines in the United States during the last 70 years

Coast, and the first dynamite company was established there in 1877. This was ten years after Alfred Nobel had patented dynamite and fulminate blasting caps in Sweden.

It is believed that nitroglycerin was first introduced in the United States in the driving of railroad tunnels in 1867, and its use for mining dates from about the same time. A chemist, James Howden, manufactured nitroglycerin on the spot when the Donner Pass tunnel was being driven through the Sierra Nevada. The speed of tunnel driving increased 54 per cent above the use of black powder, and in addition costs were lower.

The drilling technique employed in this type of blasting is of interest. When black powder was used the holes were drilled 2½ in. in diameter, but with the introduction of nitroglycerin, it was learned that holes 1¼ in. in diameter were more efficient. Skillful Chinamen would carry the nitroglycerin to the face, where it was poured into the drill holes through pipes and set off with black powder as a primer. Fuse and cap were used to fire the black powder.

Nitroglycerin was imported in San Francisco from Europe in 1866 by Julius Bandman, who had confidence that it was the right explosive for mining. He received the patent rights from Nobel, and just as he was ready to market it, Nobel advised him of his discovery of dynamite. Bandman, who organized the Giant Powder Company[2] (now a subsidiary of Atlas Powder Company), invited Winckler, one of Nobel's partners, to come to San Francisco and demonstrate the new invention.

On Aug. 10, 1867, Winckler set off a 3-lb. lot of dynamite by blasting some boulders on the Bay View Railroad. This was the first blast of dynamite in the United States. Dynamite was considered too dangerous by Eastern states, but was gladly accepted in the Western mining districts. It was more expensive than black powder, but the miners soon learned that dynamite would break more ore and lower mining costs, and it therefore became a strong competitor of black powder. The California Powder Works, the largest manufacturers of black powder at that time, felt this competition and engaged James Howden, the nitroglycerin chemist, to manufacture dynamite for them. Howden produced a dynamite lighter in weight and color which consisted of an "active dope" mixture of magnesium carbonate, sugar, and potassium nitrate and a little potassium chlorate. This dynamite was called "Hercules," which was the name given later to the California Powder Works, which, as the years went on, established plants eastward.

Blasting Gelatin

In 1875 Nobel invented blasting gelatin and gelatin dynamite. He found that nitroglycerin could be combined with collodion cotton and upon heating the combined material would become tough, elastic, and plastic. He patented these blasting gelatin and gelatin dynamites in the United States in 1876. During this time several powder companies became involved in the courts defending various patent rights concerning explosive manufacture. At the time of Nobel's invention of blasting gelatin, General Henry du Pont was convinced by Lammot du Pont, who was a chemist, that their company should manufacture nitroglycerin. It was not until 1880, however, that they manufactured their first batch, which was fourteen years after it was imported into this country. Chemical research became more intensive from this time on. Henry Sprengel proposed liquid air as an explosive in 1873, and S. R. Divine determined a method of dipping potassium chlorate into nitrobenzol on the job. Nitro starches had been known for some time, but not until 1905 was a plant erected for the manufacture of the new nonfreezing explosive, called Arctic Powder. Nyalite, a so-called safety explosive, followed a few years later.

At the turn of the present century explosives had been developed by chemists, and nitroglycerin and dynamite became guinea pigs for more experiments. There were three classes of powder in use, the straight nitroglycerin powder, with its varying percentage of nitroglycerin, ranging from 20 to 60 per cent. This class contained wood pulp, which absorbed the nitroglycerin and the chemical equivalent of sodium or potassium nitrate.

Gelatin dynamites contain sufficient nitrocellulose to form a colloid to cover the other ingredients (dopes), this protecting them from water. These powders had strengths ranging up to blasting gelatin of 100 per cent strength. The most recent and important class was the ammonia dynamite and gelatins in which ammonia replaced part of the nitroglycerin.

Improvements in the manufacture of nitroglycerin proceeded in a cautious

[2]History of Explosive Industry of America.

manner. Research and experimentation to obtain greater safety as well as increased efficiency in the growing use of explosives, and to maintain the best proportions of nitric and sulphuric acid and glycerin, engaged the attention of chemists about 1902. The production of stronger acids rendered the nitroglycerin less soluble in the waste acid and resulted in better yields. Moreover, by adding small quantities of a substance to the nitrated charge, hydrofluoric acid was produced which hastened the separation of nitroglycerin, making it more complete and adding to the safety.

Dynamite performed satisfactorily in warm weather, but when it froze there was danger of premature explosion. Nitroglycerin was considered to have a freezing point of about 55 deg. F. Harold Hibbert published results of his experiments in the *Journal of American Chemical Society,* Vol. XXXV, 978 (1913), which definitely established the existence of two solid forms of nitroglycerin, each having melting points of 2 deg. and 13.2 deg. C., respectively. These results, however, had no practical application, and it was not until 1907 that trinitrotoluol was found applicable in lowering the freezing point of nitroglycerin. About 20 to 25 parts of the liquid was dissolved in the nitroglycerin, and the result was a freezing point of 30 deg. F. This was an expensive method, so a cheaper one was found whereby a commercial naphtha would be purified and nitrated and small amounts of naphthalene added to prevent solidification in cold weather.[3] Lowering the cost of production of trinitrotoluol substituted it for the naphthalene mixture, and this was used up to the time of the World War. Some mixtures of glycerin and sugar were mixed with TNT in the making of dynamite in about 1911, which proved satisfactory as freeze-resisting slightly below zero degrees Fahrenheit. However, TNT is too expensive to be used in connection with this procedure.

In the manufacture of low-freezing gelatin dynamite it was found that nitration of glycerol ether produced tetranitro-diglycerin with about 16 per cent nitrogen, whereas nitroglycerin had 18.6 per cent. To raise the nitrogen content, tri-nitroglycerin and tetranitro-diglycerin were used in a mixture. Glycerin is a viscous liquid and is difficult to freeze under ordinary conditions. Tetra-nitro-diglycerin added to nitroglycerin lowers its freezing point, and by the use of this mixture the freezing point of dynamite, gelatin dynamite, ammonia dynamite, and permissibles was lowered. Another hazard was, therefore, removed in the science and application of explosives. Most dynamites today, however, contain ethylene glycol mixed with glycerol and then nitrated. The freezing point of this type powder is about 35 deg. below zero Fahrenheit.

Various attempts have been made to find a substitute for nitroglycerin, but no satisfactory product is as yet reported. During the World War, glycerin was made synthetically in Europe. Research in this country has made great strides in the manufacture of glycerin from both sugar and molasses. Economical processes for the manufacture of glycerin by the fermentation processes of sugar and molasses are now known, and what further research on this subject may bring remains to be determined.

Ammonium nitrate was used in explosives in Sweden in 1867. Johan V. Ohlsson and Johan Henrik obtained the first patents, and the ammonia powder consisted of 80 per cent ammonium nitrate and 20 per cent charcoal. To make it easier to detonate this powder nitroglycerin was substituted for part of the charcoal. The difficulty with this ammonia powder, however, was its hydroscopic nature, and it had to be kept in an air-tight container. Nobel perceived the advantages of the invention, and upon buying the patents he added paraffin and decreased the sweating properties of the powder. About 1882 Russel Penniman and John Schrader put up a small plant in Kenvil, N. J., and experimented with ammonium nitrate powder. Their solution was to dry and granulate the ammonium nitrate and then coat each grain with some form of petroleum jelly. Ammonium nitrate powders were welcomed to the coal-mining industry because of the low temperature of explosion. The plant at Kenvil is the oldest dynamite plant in the United States that is still operating on its original site.

Research in the manufacture of ammonium nitrate is the outstanding event in explosive manufacture since the World War. The improvement made has been in the production of synthetic ammonia gas and the oxidation of ammonia to nitric acid. From these two chemicals ammonium nitrate is produced. The trend in production of explosives has been toward the utilization of larger percentages of ammonium nitrate, which gives a more economical explosive. Another trend has been toward higher-count dynamites, whereby the cartridge strength is adjusted to the higher value.

When powder was first used in mining, it was usually ignited by means of a train of similar powder or powder-filled squibs. Safety fuse spun of cotton or hemp threads with powder introduced between them so as to form a solid rod-like core, the covering being then varnished, was developed by William Bickford, of Cornwall, England, in 1831, and greatly reduced blasting accidents. It was soon introduced in the United States by Richard Bacon, 2d, superintendent of the Phoenix Mining Company's copper mines at Simsbury, Conn., and in 1837 a factory to make it was set up at East Weatogue, near Simsbury, by the newly organized firm of Bacon, Bickford, Eales & Company. This plant burned down, and Bacon left the company, which was reorganized as the Ensign-Bickford Company. A factory to replace the one destroyed was built on Hop Brook by the new company, which now in this year of 1936 is celebrating the hundredth anniversary of the introduction of safety fuse in the United States.

With the growth of the explosives industry, safety fuse was improved in various ways. Better coatings, including one of gutta percha for submarine work, were devised. A pipe made of lead or composition and filled with powder and rolled out was invented by a Cornishman, Carbonia. In 1865, J. S. Bickford patented guncotton fuse and in 1876 William Leonard, of Boston, a ribbon of xylonite or celluloid having a friction-match composition at one end.

Finally, Louis L'Heure, of Rouen, France, devised a "cordeau detonant," or detonating string, consisting of a lead tube filled with nitrotoluene and drawn out to considerable length. This was patented in the United States in 1907 and first used here, in a Pennsylvania quarry, in 1913. A factory for making it was built at Avon, near Simsbury, in 1914, since when it has gone by the name of cordeau Bickford in this country. Cordeau detonates at a speed of 17,000 ft. per second, so fast that all charges connected to it explode apparently at the same time. For all this, in using it to blast, say, two rows of holes on a single length of it,

(Continued on page 258)

[3] "Twenty-five Years' Progress in Explosives," by Dr. Charles L. Reese. Presented at the Franklin Institute Centennial, Philadelphia, Sept. 17-19, 1924.

Production of Explosives in the United States—1925–1935[a]

United States Bureau of Mines

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935[b]
Coal mining	211,616,811	236,484,618	207,684,766	188,241,488	194,055,999	166,211,592	128,343,769	104,017,805	107,917,468	121,398,036	122,408,129
Metal mining	109,602,301	113,439,237	104,469,220	98,413,474	111,389,377	92,732,820	58,586,248	29,895,558	33,372,314	46,316,847	53,032,152
Quarry and non-metallics	78,350,095	82,676,535	84,827,530	81,125,861	84,441,410	72,661,016	51,641,358	30,843,501	31,883,737	36,627,048	37,372,690
Railway and construction	49,737,899	52,748,215	54,690,196	58,852,174	67,089,005	85,795,827	82,979,910	59,438,981	75,941,959	100,931,796	82,805,575
Other purposes (c)	52,444,740	50,541,573	47,339,416	48,618,145	52,732,569	27,689,243	16,013,618	9,691,455	6,871,913	9,494,195	8,962,474
Grand total	501,751,846	535,890,178	499,011,128	475,251,142	509,708,360	445,090,498	337,564,903	233,887,300	255,987,391	314,767,922	304,581,020

(a) Production means total sales reported in pounds each year by manufacturer. (b) Estimated by Institute of Makers of Explosives. (c) Used in agriculture, forestry, ice jams, geophysical prospecting, and other miscellaneous purposes.

Mining in Mexico Today

A. H. Hubbell
Associate Editor

III

THE PLANTS AT MONTERREY AND TORREON

SAMPLE MILL PATIO of the smelter of Cia. Minera de Peñoles at Monterrey. Here each custom sample is retained until the lot it represents has been released and liquidated by the shipper. The lots are variable in size, this ranging from a few hundred pounds up to 200 tons

Lead Smelting and Refining at Monterrey

At this rail center, conveniently situated for shipment abroad, both the Peñoles and Asarco companies have establishments

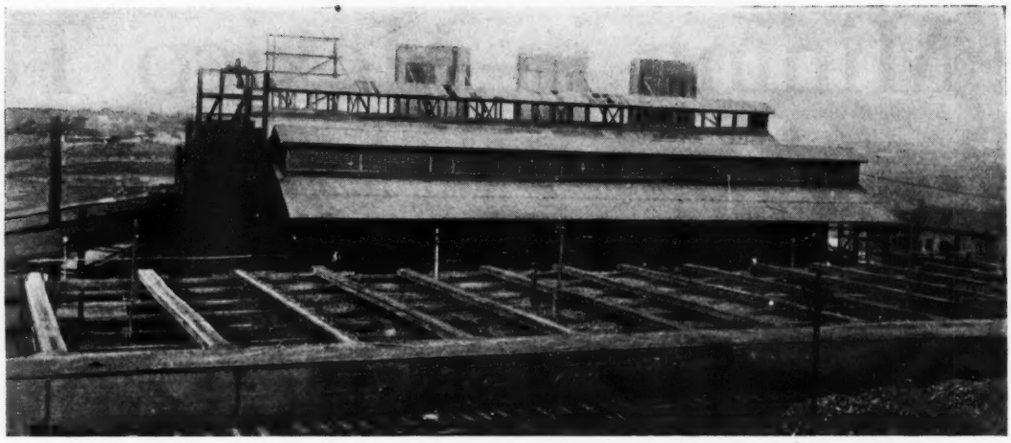
MONTERREY, capital of the State of Nuevo Leon and metropolis of northern Mexico, a town of 150,000 inhabitants, has long been one of the important smelting and refining centers of Mexico's non-ferrous mining industry. Situated at an elevation of 1,624 ft. on the main line of the National Railways between Laredo and Mexico City, and at the junction with the lines from Torreon on the west and Tampico on the east, on the Gulf Coast, it is well located for receiving ores and other materials from all parts of the Republic and for shipping its bullion, whatever be the destination. A supply of coal and coke is available, moreover, in the Sabinas-Rosita area in Coahuila, only 215 miles by rail to the north. Today, the town boasts a lead smelter and two refineries, as well as one of the two steel plants in the country.

Here at Monterrey are the headquarters of the American Metal Company's subsidiary in Mexico; namely, the Cia. Minera de Peñoles, of which G. H. Harbordt is general manager and W. F. Jahn, assistant manager. From these offices are directed the operations of the company's various divisions, principal among which are the local smelter and refinery and the smelter at Torreon, both of them custom plants, as well as the Avalos, Sierra Mojada, and Achotla units, which supply them with ores, concentrates, and other materials. In addition, the company operates a number of other mining units on a small scale, units that were formerly large producers. It is active in exploration work and is developing several mines which it has under consideration.

A brief word as to the units named will serve to complete the general picture of the company's operations: The Avalos unit is at Avalos, Zacatecas, and is a lead-zinc-silver producer. A flotation plant of 275 tons' daily capacity is under consideration, and will probably be put in operation soon, for milling complex sulphide ores. The direct-smelting ores will continue to go to the smelters. The Sierra Mojada unit, at Esmeralda, in Coahuila, yields limy silver ores and irony lead ores, which also are shipped direct. The Achotla unit, at Temisco, Guerrero, produces silver and gold and operates a chloridization and cyanide plant, the precipitates of which are sent to the company's smelters.

Operations of the company's metallurgical plants at Monterrey and Torreon are conducted through a subsidiary of the Cia. Minera de Peñoles, known as the Cia. Metalurgica Peñoles. The plant at Monterrey is supervised by U. H. Berthier, with Karl J. Mee as assistant superintendent. That at Torreon is under A. J. Halbert. Such information regarding the two establishments as is presented in these notes was obtained largely through the kindness of Messrs. Berthier and Halbert, supplemented by the aid that one's eyes can give in the course of a visit that, as usual, is necessarily all too brief.

The Peñoles smelter at Monterrey draws its supply of ores and other materials from a wide territory, the bulk, however, coming from Coahuila and Zacatecas and part from Nuevo Leon. High-grade concentrates as well as ores are also received from the states of Guerrero, Jalisco, Mexico, and Oaxaca;



THE NEUTRAL BEDS

and a rear view of the blast furnaces at the Peñoles smelter at Monterrey. Here the direct-smelting ores are bedded in neutral mixes, which with sinter, coke and flux go to make up the furnace charges

and from the entire country come cyanide precipitates and base bullion for the refinery.

Present operation of the smelter is at approximately 25 per cent capacity, with 740 men employed, compared with 1,500 in 1929. Metallurgical practice at both smelter and refinery departs little from what is considered standard, according to Mr. Berthier. Equipment in the smelter includes four blast furnaces, a sintering plant having one Dwight-Lloyd machine, a baghouse, and a crushing and screening plant for preparing lime rock and coarse oxidized ores as well as other ores containing considerable fines.

Sampling Practice

Of considerable interest is the sampling procedure employed, this on three counts: the wide variety both in the character of shipments received and in the size of lots; the amount of hand labor used; and the special equipment devised. The method, in short, is a compromise between hand labor and mechanical methods and involves the use of portable conveyors and portable Vezin samplers. The latter were designed and built at the plant. The practice, moreover, calls for the retention of the full sample on the smelter patio until the lot it represents is released and liquidated by the shipper.

Although the amount of manual labor required is large, it is less than required by the sampling methods that were used here up to five years ago. The procedure is also more satisfactory than a large automatic sampling plant would be, both by reason of the aforesaid widely varied character of the materials handled and the size of lots, the latter ranging from a few hundred pounds up to 200 tons.

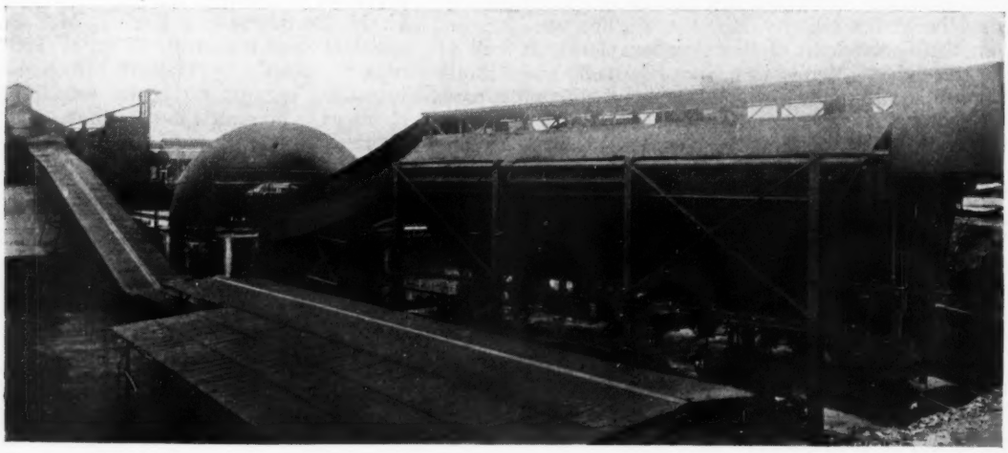
Every lot is cut by hand by the unloading crew, the part taken ranging from 5 to 50 per cent of the total, depending on the grade and character of the material. Large samples of coarse low-grade ores are put through a jaw crusher and cut 1 to 1 by shoveling from the point of the crusher discharge. The part taken then goes to two rolls, where it is broken to about $\frac{1}{4}$ in. and is discharged directly to a portable conveyor or shoveled onto one of these conveyors which delivers directly to a portable Vezin sampler, as shown in an illustration, where one-tenth or one-fifth is cut for the finishing rolls. When concentrates and fine materials are being sampled, coning and circling are performed to insure thorough mixing, after which the lot is put through the Vezin sampler in the same manner as the other material.

The purpose in following this procedure is to obtain samples of about 400 to 800 kg. in size for the finishing rolls. When such a sample is obtained, it is coned and quartered, and then cut in half, the two halves forming the original and duplicate sample respectively for that particular lot. This is then crushed in the finishing rolls, the discharge being passed through a $\frac{1}{8}$-in. screen to remove metallics. The metallics are weighed and taken into account.

The original and duplicate samples, after passing through the finishing rolls and over the screen, go next to an automatic Jones sampler, where each is cut down to approximately 6 kg. for the bucking room. Here the equipment consists of two coffee mills, an automatic mixing cylinder, and a Braun pulverizer. There are two of these bucking rooms, one for the original sample and the other for the duplicate. The original and duplicate samples, as finally obtained by the procedure described, must check in the laboratory. If they do not, either the control sample or the lot is resampled. The control consists of a 25- to 50-kg. sample taken from the last cuts on the Jones sampler or on the plate.

This method still calls for fifteen to twenty men in the sampling department proper, not including the unloading crew of seven men. The latter work wholly on contract and are supposed to unload the lot, cut the sample, and clean the car. A crew will unload a 45-ton car in 45 min. to 1 hour. They usually handle three to four cars a day, working from 7 a.m. to noon.

In the sintering plant, the single Dwight-Lloyd machine is 42x264 in. in dimensions. Double roasting is not



CHARGING THE FURNACES

at the Peñoles smelter is accomplished by the aid of a belt conveyor which receives its ores, fuel, and flux beneath the shed seen in the foreground and ascends to the charging floor of the furnaces at the left, where it discharges to a distributing shuttle conveyor. At the right are the five so-called equalizer bins, holding, respectively, neutral ore, sinter, returned slag, and flux. A weigh car is seen in the lower right

practiced, because the amount and character of sulphides received at present does not justify the additional expense; and because there is not capacity to double-roast all of the material to be sintered. The average charge is composed of 20 to 35 per cent of sulphide concentrates, the remainder being fines screened out from the oxide and siliceous ores. The sulphur content is 6 to 9 per cent before roasting and 1.5 to 3 per cent after roasting. When the sulphur is insufficient for ignition, dry, fine coal is added to help.

Depth of bed varies between 5 and 9 in., depending on the sulphur content and other characteristics of the charge. The sintered product discharges over a 1-in. grizzly and the fines that pass through are returned with the charge. They usually amount to 15 or 20 per cent of the weight of new charge. Ignition is started by a 4-in. injector-type natural-gas burner with a 6x10-in. rectangular firebox across the width of the pallets. Usual tonnage is 125 to 135 tons per machine day. The sulphur elimination is 70 to 75 per cent.

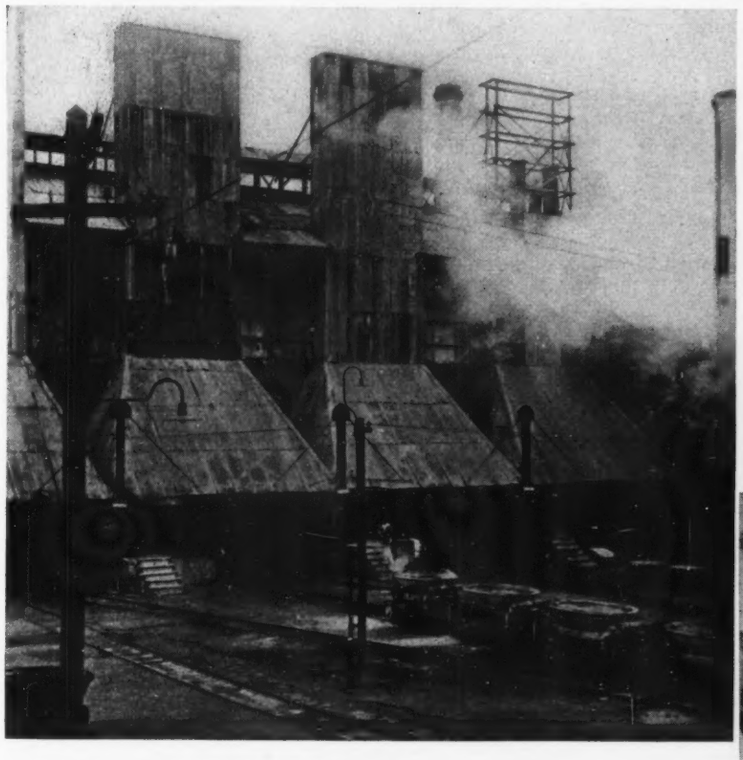
The furnaces include one 44x140-in. unit and two 48x180-in. furnaces, with 18-ft. columns and Australian tops. The small furnace is normally used only for antimonial slag charge and has a capacity of about 160 tons per day. The larger furnaces handle about 200 tons of lead charge per day.

The lead charge is usually composed of about 40 per cent sinter and 60 per cent direct-smelting siliceous, oxide, and limy ores. It assays about 8 grams gold, 1,600 grams silver, 15 per cent lead, 0.5 per cent copper, 18 per cent silica, 12 per cent iron, 12.5 per cent lime, 6 per cent zinc, and 1 per cent sulphur. The antimonial slag charge is composed of 88 per cent antimonial slag and 12 per cent iron and lime fluxes and scrap iron. Slag amounting to 30 per cent of the weight of the charge is returned to the furnace to supply sufficient slag fall. The antimonial slag smelted has about 60 per cent lead, about 12.5 per cent arsenic, and 10 per cent antimony.

The slag passes through a settler box from which matte is tapped, and then through a settler pot and on to the slag pots. Settler boxes are changed twice a week and settler pots three times daily. The bullion flows out through an overflow lead well into a small drossing kettle, from which it is tapped into lead molds of about 1-ton capacity. The pigs of bullion are trammed to a craneway, where they are loaded into railroad gondolas and shipped to the refinery. At present only one furnace is operating.

Another operating detail of interest is the method of charging the furnaces. Here, in contrast to the sampling procedure just described, the work is effectively and uniformly done with the minimum amount of hand labor by elevating the charge materials by an inclined 24-in. belt conveyor to the top of the furnaces, where they are delivered to a transverse horizontal shuttle conveyor mounted on a carriage that runs the full length of the four furnaces on a crane runway which is about 35 ft. wide. This conveyor not only has motion bodily for the length of the furnaces but it also oscillates as a unit back and forth in line with its own longitudinal axis, so that, with the aid of a swinging chute which receives the material discharged from it, it can be made to deliver charge to any one of the four furnaces at any point of its horizontal cross-section. Its design, with that of the swinging chute, is shown in the accompanying drawing.

The method of making up the charge and delivering it to the conveyor has also been interestingly mechanized in part. The materials include sinter, direct-smelting ores, coke, and flux. Sinter is discharged from the sintering machine hot into cars, and, after being wet down, is trammed to the foot of an incline belt conveyor, which discharges into so-called equalizing bins, built of steel and of the suspension type. Direct-smelting ores are bedded in neutral mixes, from which beds they are reclaimed by contractors who deliver them to the conveyor that feeds the bins. All fluxes, as well as ores, are trammed by hand onto the same conveyor belt, which is 24 in. wide and delivers to a horizontal conveyor and tripper on top of the bins. There are five of the latter, those used for neutral ore holding about 125 tons, the others

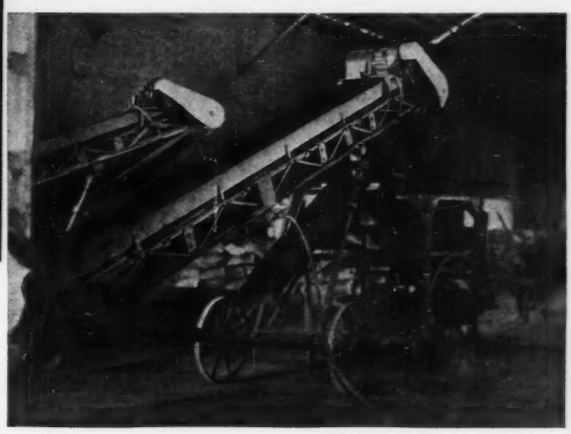


AT THE BLAST FURNACES

of the Monterrey smelter of the Peñoles company. Two of these are 48x180 in. at the tuyeres and run on lead charge. The third is 44x140 in. in dimensions and normally takes an antimonial slag charge. Australian tops and an 18-ft. column are used

PORTABLE CONVEYORS

at the custom sampling mill of the Peñoles smelter at Monterrey. The one on the right is discharging to one of the portable Vezin samplers mentioned in the text, which were developed at the plant. Considerable hand labor is used in the sampling method employed, although much less than formerly



being of half that capacity and used for holding sinter, returned slag, and flux respectively. Returned slag from the smelter patio is sent to a storage bin over the conveyor, to which it is delivered as wanted and not mixed with charge. The flux bins discharge through a chute and a hand-operated arc gate. The larger bins discharge each onto a pan feeder.

For transferring known quantities of the charge material from the bins to the conveyor that feeds the furnaces, two weigh cars, each equipped with a Toledo scale, are used. Each has 5,000-kg. capacity and weighs to 10 kg. These cars deliver their contents to shallow hoppers built beneath the track and over the foot of the conveyor that feeds the furnaces. Two hoppers receive ore charge, one slag and two coke.

The baghouse has seven sections of 150 bags each. The bags are woolen and are 18 in. in diameter and 30 ft. long. Gases are forced into the baghouse by a No. 12 Sirocco fan, actuated by a 50-hp. motor. The normal pressure in the baghouse runs up to 1½ in. of water. The dust is sintered in the baghouse and then taken to the blast furnace, where it is returned gradually to the charge. When the arsenic in the dust builds up to 35 or 40 per cent, the fume is shipped to Torreon for treatment.

In the refinery there are six 72-ton cast-iron kettles for melting and decopperizing the bullion. There are also three 130-ton reverberatory softening furnaces followed by four 72-ton cast-iron desilverizing kettles and two 130-ton welded sheet-steel desilverizing kettles, in which the bullion is treated by the Parkes process. Dezincking is accomplished by the Harris process in two 125-ton welded sheet-steel kettles. The Betterton process is used for debismuthizing, and is carried on in two 140-ton welded sheet-steel kettles. For liquating there are two 15-ton cast-steel kettles. Two 72-ton cast-iron storage kettles supply the molding ring, where the fine lead is molded by hand in 100-lb. pigs. The bullion is dip-sampled after drossing, and the dry dross produced is weighed and sampled separately.

Following a fire on Feb. 18, 1935, in which the parting plant was burned, a new building was constructed on the same site. Instead of using the old continuous Moebius-Nebel process, which had been in successful operation for almost forty years, it was decided to install the Balbach-Thum cells, and the Wohlwill process for refining gold.

The new tank room contains 121 concrete tanks lined with Harvel, with the usual graphite and carbon plates serving as cathodes. Daily capacity is approximately 500 oz. of refined silver per tank. The silver crystals are melted down in a small gas-fired reverberatory furnace with a capacity of 110,000 oz.

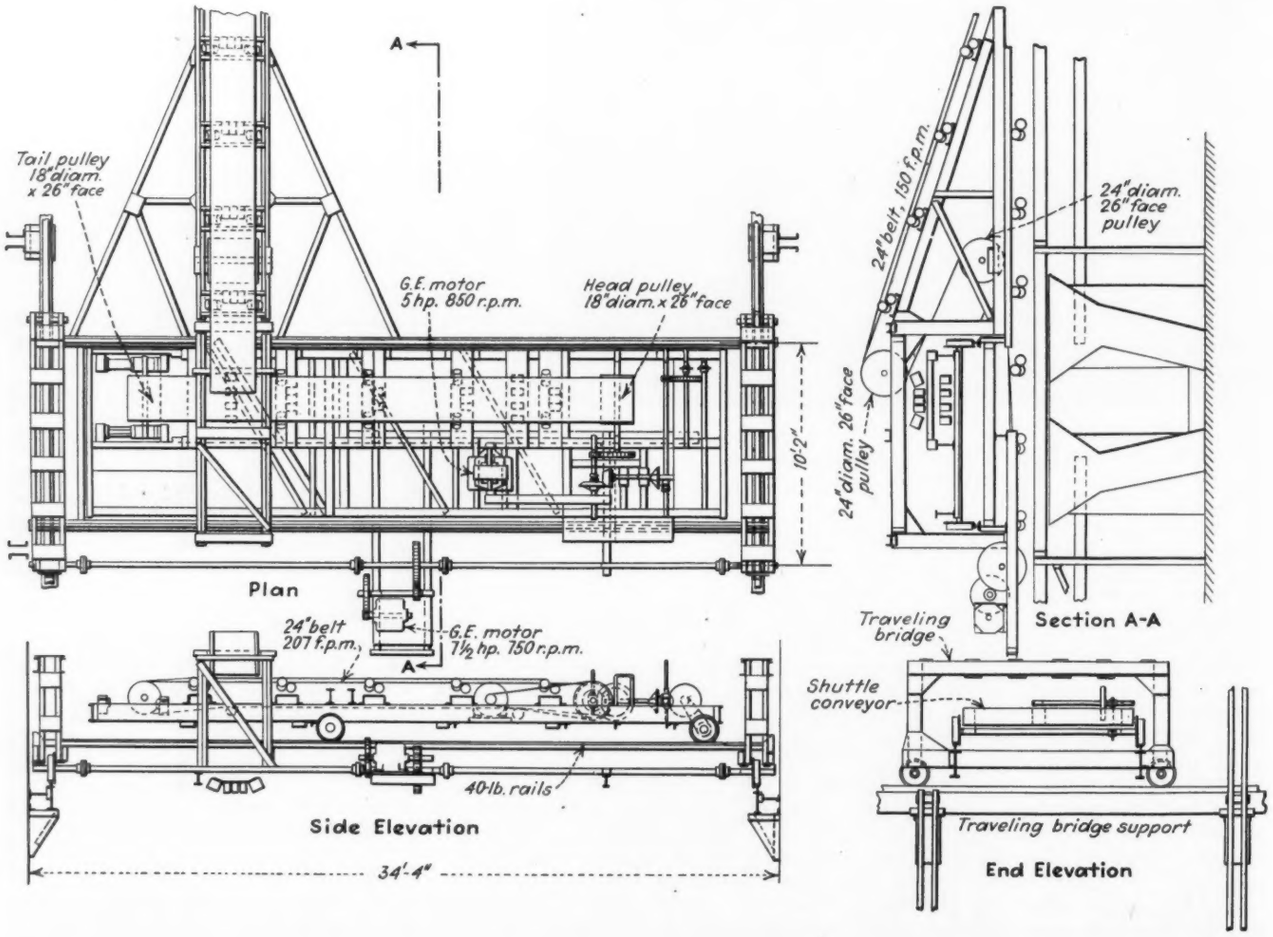
The gold mud, after removal from the parting cells, is centrifuged, and then treated with nitric acid to remove practically all of the remaining silver, after which it is cast into anodes for the Wohlwill cells, of which there are three. Present production of gold is approximately 10,000 oz. per month.

A. S. & R. Lead Refinery At Monterrey The Company's Largest

At Monterrey also is the largest lead refinery operated by the American Smelting & Refining Company, or its subsidiary, the Cia. Minera Asarco. It has a capacity of 16,000 tons of bullion per month. In it is refined the entire output of the Chihuahua smelter and of

THE MECHANICAL CHARGING SYSTEM

used at the blast furnaces of the Peñoles company's Monterrey smelter is here shown in its general features. The feeding conveyor, which delivers to the shuttle, is to be seen, housed, in one of the accompanying photographic cuts.



the San Luis Potosi smelter, both of which have been described in recent issues of *E.&M.J.* The bullion is shipped by rail to Monterrey and, after being refined, the lead is sent to Tampico by rail and from there to all parts of the world by fast ocean freight. The gold and silver produced moves by express to the Government banks and Mint at Mexico City.

In the refinery, Harris softening and Harris dezincking processes are employed, due to which fact the plant is largely an all-kettle refinery. The operations for the most part are carried out in eleven 200-ton welded steel kettles.

Bullion upon being charged into the pre-melting kettles is drossed by the dry-dross method and the entire lot sampled in the kettles by the dip method.

Design of the plant is such that the entire refining of the bullion takes place under one main craneway, on which three cranes operate.

Inasmuch as large quantities of arsenic, antimony, and tin are handled per day in the Harris softening unit, the auxiliary equipment, or so-called "wet-process equipment," must of necessity be modern and of large capacity to separate out the sodium salts of arsenic, antimony, and tin effectively and to regenerate the final caustic soda required for the softening operation.

The Harris wet plant for treating the byproducts of softening is entirely separate from the wet plant in which the zinc salts are treated. Separate evaporating systems are employed to recover the caustic soda from the weak caustic liquors to avoid any interchange of the fused caustic recovered from the dezincking process with that recovered from the softening process.

By the Parkes desilverizing process the gold and silver are separated out in an enriched dross, which is transferred to the retorting department, where the usual Faber du Faur retort furnaces are used. The cupels are of the Omaha type.

The refinery is also equipped with a modern parting plant employing the Moebius process for the separation of the silver and the Wohlwill process for gold. This plant has a capacity of 3,000,000 oz. of refined silver per month.

A large portion of the lead bullion refined contains considerable amounts of bismuth, and all of this tonnage is debismuthized, employing the Betterton debismuthizing process. All of the refined lead is cast on the so-called "Straight-Line" molding machine.

At present 420 men are employed in the refinery. Carl Gall is the resident manager. Safety, health, and welfare play an important part in the successful operation of any plant, and the men at Monterrey are provided with modern change houses, bath houses, and lunch rooms. Stringent rules are enforced in order that these accommodations may be immaculate at all times. A plant doctor and three nurses care for the health of the men and of their families.

THE TORREON SMELTER of Cia. Minera de Peñoles, as seen from the company's office outside the adobe wall that surrounds the plant. To the left is the crushing and sampling plant. In the middle, to the right of the tree, may be seen the tops of the furnaces

Peñoles Smelter at Torreon Also a Lead Plant

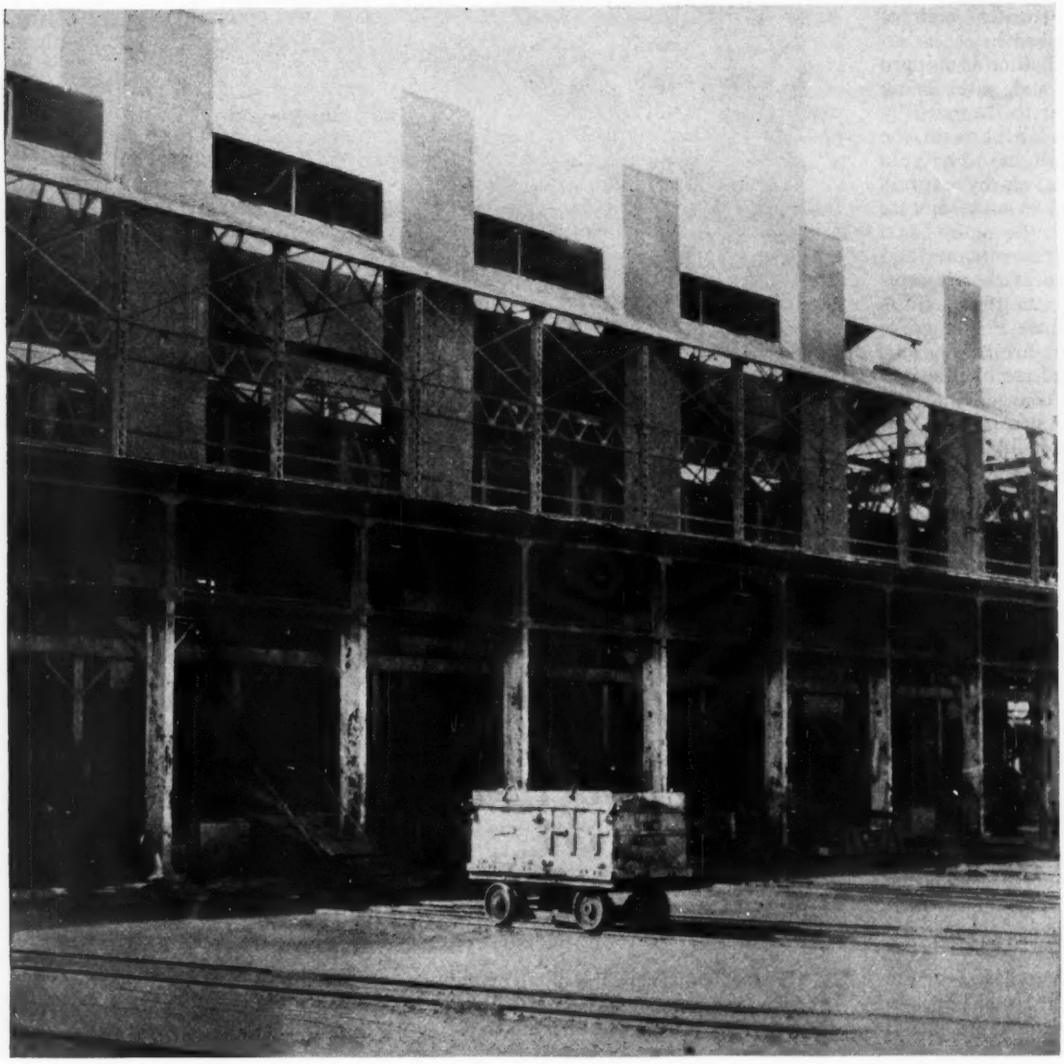
Its bullion is shipped to Monterrey for refining . . . Arsenic recovered from dust and fume

TORREON, where the other of the two smelters of the Peñoles company is situated, is a thriving, fast-growing modern town of 26,000 population. It is somewhat higher than Monterrey, standing at 3,790 ft. elevation. Just as the latter town is on the 800-mile line of the National Railways running from Mexico City to Laredo, so Torreon finds itself some 700 miles from the capital on the division that stretches over 1,200 miles northwestward to El Paso. These two divisions are linked together between Torreon and Monterrey, just as further south they are tied between San Luis Potosi and Aguascalientes, affording an effective rail network for the territory covered.

The Peñoles smelter here is under A. J. Halbert. It is a lead plant also, and draws its ores from all over the Republic, some of the districts being Avalos (in Zacatecas), Parral, Mazatlan, Sierra Mojada, Ahumada, Naica, and Monclova. Its principal tonnage comes from the San Francisco Mines of Mexico, in Chihuahua, which ship about 6,500 tons per month; also from the various Peñoles units, which monthly send a total of approximately 4,500 tons, the remainder coming from many widely scattered points. Receipts in terms of metal amount to approximately 4,500 tons of lead per month, 20,000 kg. of silver, and some 200 oz. of gold. In addition, about 250,000 kg. of metallic copper contained in lead ores is received monthly. When separated, this is shipped to the A. S. & R. plant at San Luis Potosi for lack of converters. In the last six months of 1935 the plant was smelting at the rate of 277,000 tons per year and employing 800 men.

As equipped, the smelter comprises a sintering plant, with a baghouse for dust collection; six lead furnaces, of which five are in commission, with a Cottrell precipitation unit; and an arsenic plant.

The sintering plant contains five 42x264-in. Dwight-Lloyd machines. These handle 6,500 tons of concentrate per month and 2,000 tons of sulphide ores with enough oxidized diluent to give a total of 13,000 tons of roasted charge monthly for the furnaces. Double roasting is practised, the first and second machines always being on first roast, the fourth and fifth on second roast, and the third machine being part of the time on each. A 10-in. bed is carried on the first roast and a 6-in. bed on the second. About 175 tons is fed per day to each first-roast machine. This feed runs about 11 per cent sulphur, which is reduced to 4.5 to 5 per cent on the first roast. The discharged first-roast sinter is crushed to minus $\frac{3}{4}$ in. in corrugated rolls and then in fine rolls to minus $\frac{1}{4}$ in. About 1 per cent of finely crushed coal is added to make the charge for the second roast, in which the sulphur is reduced to $1\frac{1}{2}$ per

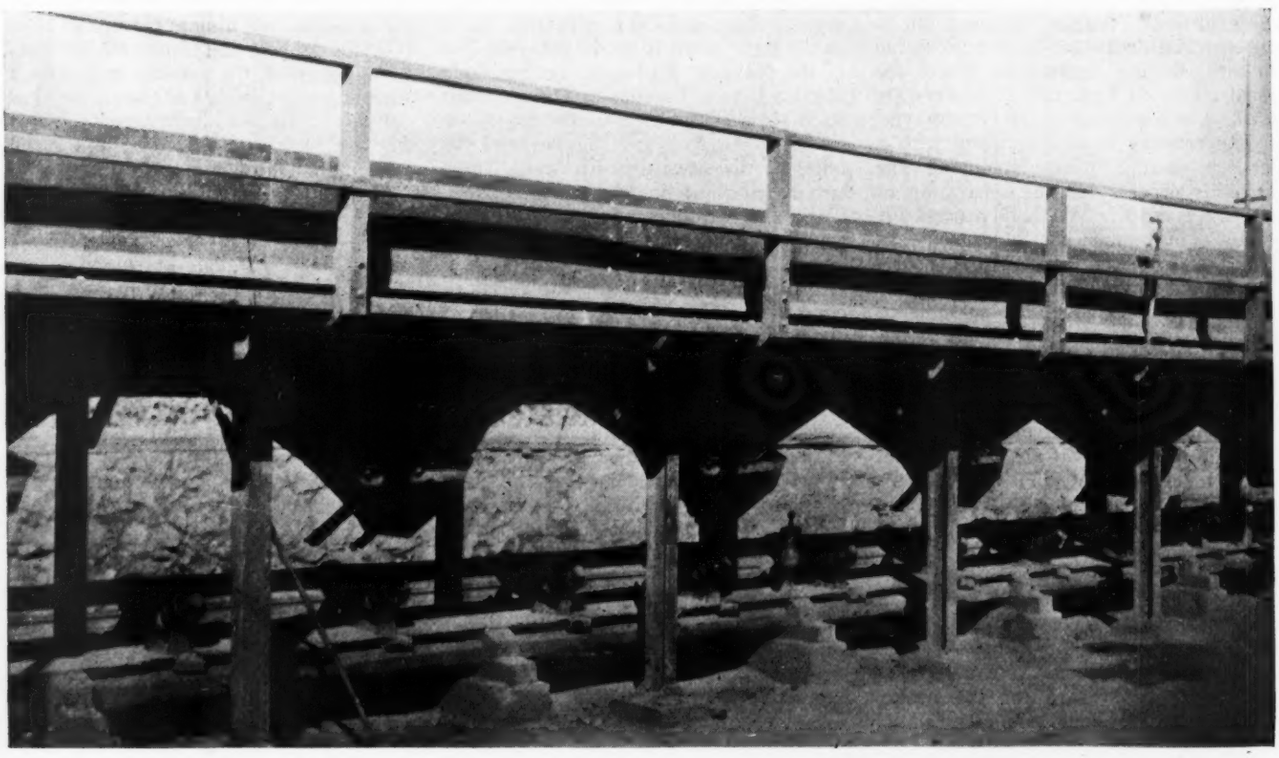


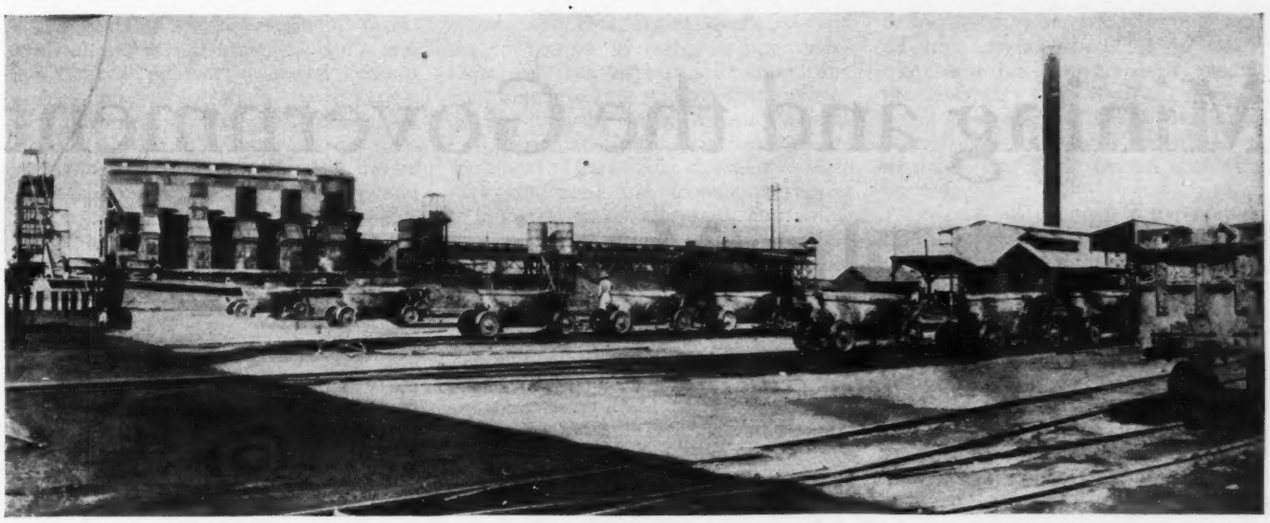
BLAST FURNACES

of the Torreon smelter of Cia. Minera de Peñoles. They are six in number, five of them having been in commission at the time this article was written. A Cottrell precipitation unit serves them. In the last six months of 1935 the plant was smelting at the rate of 277,000 tons per year. The sintering plant (not shown) stands at the right of the furnaces and at right angles to them, across the switching yard

HOPPERS

for receiving oxidized ores at the Torreon smelter. The fines are screened out subsequently and are used as a diluent in sintering. At the time this photograph was taken the sintering machines were handling 6,500 tons of concentrate and 2,000 tons of sulphide ore per month, with enough oxidized diluent added to bring the total tonnage roasted monthly up to 13,000





THE SWITCHING YARD

in front of the furnaces at the Torreon smelter. The tracks lead to the furnaces, which are out of the picture to the left. Across the yard at the left of the photograph is the sintering plant. It houses five 42x264-in. Dwight-Lloyd machines

cent. Feed to all machines runs about 8 per cent in moisture, determined approximately by pinching.

Materials for the charges for the sintering machines are sent first to 50-ton mixing bins below the machines. These are arranged in two rows of six, on either side of a central conveyor, to which each bin delivers as required by means of a belt feeder. One row serves the first roast machines and the other the second-roast. The central conveyor discharges to an elevator, which in turn delivers to the feed hoppers above the Dwight-Lloyds, taking first from one row of bins until the corresponding hoppers above are filled and then from the other row. Specific-gravity determinations are made of all materials entering the first-roast charge to determine its character in this respect.

The six furnaces are 46x162 in. in dimensions at the tuyeres and have Australian tops. The active smelting column is 19½ ft. high. About 56½ per cent of the total charge smelted is roasted material. The average composition of the furnace charge, as given by the company's office, is: gold, 6 oz.; silver, 800 oz.; lead, 17 per cent; copper, 1.2; zinc, 6.2; silica, 15.6; iron, 12.6; lime, 12.1; sulphur, 1.3; and arsenic, 1.3 per cent. The charge is made up in a hopper, and thence dumped into a charge car, holding 3,400 kg. exclusive of fuel, which is elevated to the charge floor.

In smelting, practically no lead matte is produced. Average composition of the slag is: silver, 8 oz.; lead, 1.38 per cent; copper, 0.17 per cent; silica, 26.8; FeO, 24.5; MnO, 1.45; CaO, 13; MgO, 1.21; ZnO, 10.2; alumina, 4.3; and sulphur, 1.3 per cent. Settling equipment consists of two forehearths, of respective capacities of 10 and 1½ metric tons. The larger is changed once every 24 hours and the smaller every 3 hours. Lead from the furnaces goes in 1½-ton pitchers to three 72-ton cast-iron kettles, the end ones being higher than the center ones. These are oil-fired. The bullion is poured into the outside kettles, each of which has a baffle toward the inner side. It passes down under the baffle and overflows to the center kettle, being drossed in each kettle to remove the copper. From a low depth in the center kettle it is pumped to 1¾-ton molds, the lead blocks thus made being loaded by crane into open box cars and sent to Monterrey for refining. By the drossing operation the copper is removed, the dry dross going to a reverberatory, which yields lead bullion, high-grade copper matte, and speiss. By this means the copper remaining in the lead as finally cast is held down to 0.01 or 0.02 per cent without other procedure. The average composition of the dry dross is: gold, 22.3 oz.; silver, 3,516 oz.; lead, 64.3 per cent; copper, 18.4; and arsenic, 8.16 per cent.

Arsenic is recovered from the dust and fume, which are caught thus: The sintering plant gases go to a seven-section baghouse having 156 bags per section. Bags are of wool and 18 in. by 30 ft. in size, and made in Mexico. The furnaces are equipped with a Cottrell precipitation unit. The dust caught in both ways is roasted in a Godfrey roaster, the resulting black arsenic (93 per cent As_2O_3), being then further treated (refined) in a reverberatory, where the gases are volatilized and collected by condensation in chambers. From these it is removed in 500-kg. iron carts, and dumped through a floor opening to a housed conveyor. This delivers it to a ball mill, which discharges to a barrel on a shaking table, all housed. Part is sold in Mexico, but most of it is exported to the United States. Production of refined arsenic (99.2 per cent As_2O_3) is about 150,000 kg. (325,000 lb.) per month. The barrels conform to United States Interstate Commerce Commission specifications.

Power is purchased from Cia. Nacional de Electricidad. In contrast, the company's Monterrey plant makes its own power.

RECEIVING PATIO

of the Peñoles smelter at Torreon. As at Monterrey, the lots received are variable in size and are held here until released by the shipper. They come from all parts of the Republic

Mining and the Government In Mexico

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THE POINT OF VIEW of the Federal Government of Mexico respecting the mining industry is the same as that expressed in the Administration's Sexennial Plan, namely: The nationalization of the subsoil shall be made effective. Second, zones of mineral reserve shall be established to safeguard the future national interest. Third, an official exploration service shall be created in order to conduct new mining exploitation and with a view to making special surveys of zones where private individuals would not be allowed to operate by reasons of a technical or economic character.

The Government's program respecting the mineral industry during 1936 therefore includes the following:

1. New zones of national mineral reserve are to be created, within which mining grants will be issued in preference to cooperatve labor organizations.

2. The special mineral surveys required by the Sexennial Plan are to be made.

3. The mining law will be amended so as to facilitate the working of placer formations by the *gambuzino* or *placerero,* and also in order to permit the issuance of grants within the zones of national mineral reserve exclusively to Mexicans and Mexican companies, thus taking a step towards the true nationalization of the mineral industry and its organization under the cooperation of the Federal Government.

4. A strong campaign is to be undertaken in regard to the enforcement of legal provisions pertaining to sanitary conditions, safety, and first aid in the mines and metallurgical plants, and the Government intends also to see that workmen suffering from professional diseases be given adequate work without endangering the health of the rest of the laborers.

5. During 1936 several ore-treating and metallurgical plants are to be erected in regions already surveyed where mining activities are being undertaken by small miners.

6. The financial organization for the relief of the mining industry is to be stimulated by introducing whatever facilities may be required, both as regards legislation and taxation.

Certain features of the Administration's program for 1936. . . . Recent legislation and other activities

7. The Finance Department is to revise, amend, and readjust the tax legislation so as to make it more comprehensive, more equitable, and more practical in its application, taking care of distributing the burden of taxation in a manner proportional to the earning capacity of the taxpayers.

The Status of Legislation

Mineral substances subject to the provisions of the Mexican Mining Law as regards their exploitation and treatment are now classified as follows: Metallics; non-metallics, including guano and amber; and, third, coal and graphite. The right to exploit and treat these mineral substances is acquired direct from the nation represented by the Federal Government through the Ministry of National Economy, Department of Mines, at Mexico City.

Mineral concessions or grants are issued by the Federal Government to individuals, either Mexican or foreigners, and to Mexican companies, in four ways, namely: Exploration grants called *cateos,* after the old Spanish terminology; second, exploitation grants for regular mining work; third, treatment concessions for metallurgical and ore-dressing plants and smelters, and fourth, special grants for the exploitation of mineral deposits and placer ground in the zones of national reserve.

The surface unit in mineral land is the *pertenencia* or hectare; that is, a square 100 meters each side, equivalent to 2.47 acres, with unlimited depth. A mining claim is the *pertenencia* or a group of adjoining *pertenencias* covered by only one grant. Each exploration concession comprises an invariable area of nine *pertenencias,* or a square 300 meters long on each side. No individual in the Republic is entitled to more than one exploration claim. The exploitation claims may cover any area up to 100 *pertenencias* in metallics and non-metallics, and up to 1,000 *pertenencias* in coal.

Exploration claims or grants are effective for two years. During this time the grantee has an exclusive right to turn them into exploitation claims. The latter may be held as long as the Federal surface taxes are paid and the regular assessment work is done. Failure in either case would cause forfeiture.

Mining titles issued before Aug. 1, 1926, are subject only to the obligation of the patentee to pay the regular area tax, no assessment work being required in this case. Exploration claims (*cateos*) are not subject to the payment of the surface tax and to the performance of assessment work; the grantee has a right to explore the mineral land within the nine *pertenencias* and also, upon application and after the mineral surveyor's report is filed, he may secure the right to use, sell, and treat whatever ores may be produced.

The beneficiary of an exploitation grant has a right to build within or without the boundary lines of his claim, roads, railroads, store houses, offices, houses, aqueducts, pumping plants, electrical transmission lines, and ore-dressing and metallurgical plants, to be used in connection with the mining work.

Construction and operation of metallurgical and ore-treatment plants and smelters are subject to special Federal concessions, except when the owner of a mining exploitation grant desires to build a plant for his private use. In such case the plant capacity shall not be over 25 metric tons per 24 hours, and 20 per cent of its capacity shall be devoted to the treatment of ores received from the public.

Construction and operation of custom mills or public treatment plants is regulated by special concessions and under treatment charges that may be approved by the Government.

The beneficiary of any Federal mining concession also has the right to use whatever land may be necessary for mining and milling operations, for buildings, mine dumps and tailings; also to drive through adjoining mining claims whatever mining works may be required for unwatering, ventilation, and haulage purposes; also to acquire the right-of-way through adjoining property in order to build roads, aerial tramways, ditch lines, electrical transmission lines, and the like; and, finally, to use for mining and milling operations the water that may come from mines.

The Public Mining Registry has been established in the Mines Department for the purpose of recording: (a) the articles of organization, by-laws and amendments thereto of mining companies or of companies that, although not organized for mining purposes, may have to acquire mining concessions or mining property; (b) the Federal concessions or grants isued for mining, milling, and metallurgical operations and the conveyance of rights arising therefrom; (c) the leases, options, and any contracts affecting mining operations or dealing with the exploration or exploitation of mining claims, ores, or with ore treatment; (d) mining easements. Any acts, contracts, and documents subject to registration as aforesaid, and which may not have been recorded in this Registry, will not affect the third parties and will not have any legal value before the Federal Government.

The Secretary of National Economy has authority to establish national mineral reserves already mentioned within the free mineralized zones for the following purposes: (1) To encourage and stimulate the exploitation of mineral land in isolated, unexplored, or abandoned regions by issuing special grants. (2) To encourage small miners and cooperative mining organizations in regions affording opportunity for the development of mineral resources on a small scale. (3) To control and regulate the production and distribution of minerals so as to counteract the unbalanced conditions of the metal market. The national mineral reserves comprise minerals, zones, and placers. The latter, in any case, have been automatically incorporated into the national reserves.

Special concessions or grants in the national reserves are issued only to those individuals or Mexican companies showing enough technical and economical resources to undertake mining operations. The area to be covered by only one grant is nine *pertenencias* (a square 300 meters on each side). It could formerly be increased by another adjoining square of nine *pertenencias*. This last requirement has been recently modified, the Secretary of National Economy being now empowered to issue special concessions exclusively in placer formations (tin, gold) for an area of unlimited size.

Concessions granted in national mineral reserves are required to pay not only the regular mining taxes (production and area), but also a 5 per cent royalty on the gross production. This is controlled by a mining inspector appointed by the Mines Department. His compensation is paid by the grantees.

Under the provisions of the amendments to the Mining Law enacted on Aug. 30, 1934, a Committee for the Development of Mining Industry was created, but up to the present time it has not been organized.

It must be borne in mind that, according to the Mexican Constitution, all mining activities fall under Federal jurisdiction, and local or State legislation on the subject is prohibited.

On April 11, 1935, a Federal decree was issued levying a special tax on silver production, which has been referred to on more than one past occasion and of which the details are as follows: On ores, 6 per cent; on concentrates, 5 per cent; on precipitates, 4 per cent; and on refined bullion, 3 per cent. When the New York silver quotation exceeds $0.33 United States currency and not $0.66 United States currency per ounce, the above taxation shall be increased 1 per cent for each $0.04 increment in silver value; for a higher silver price be-

ING. MANUEL SANTILLAN,

a mining engineer and geologist who is at present the Under-Secretary of National Economy. He was formerly in charge of the Geological Institute of Mexico, and his contributions to the geological and mineral survey in Mexico have been important

ING. ANDRES MANNING,

a mining engineer now in charge of the Mining Department of the Federal Government in Mexico City. His activities in government offices and with private enterprises have established his record as one of the present-day mining leaders in Mexico

tween $0.66 and $1.00 per ounce, the taxation should be figured as aforesaid up to the $0.66 United States currency mark, and for the exceeding value 50 per cent thereof shall be collected. For a price higher than $1.00 United States currency per ounce, the tax shall be calculated as already explained up to the said $1.00 mark, and on the excess 75 per cent of the value shall be collected.

Both the large and the small mine operators in the Republic filed a protest against the levying of such a tax, arguing that in reality it amounted to paying the Government a royalty on the national silver production.

The consequences of this policy, as predicted by the mine operators, have been (1) The exploitation of large known low-grade orebodies which in Mexico constitute the main item in the assets of mineral resources was not made possible. (2) The rehabilitation of old mining camps, which due to economic conditions had remained inactive, could not be effected by large mining organizations. (3) Mining operations could not be conducted in regions distant from the railroads where mining costs were high.

Other Activities of the Government

Up to October, 1935, patents on mining claims were granted by the Federal Government as follows: Exploration mining claims (*cateos*), 1,859 covering an area of 16,731 hectares; exploitation mining claims, 2,011, with a total area of 87,402 hectares. For the exploitation of zones in the national reserves in auriferous regions no concessions were granted during the year.

Fourteen concessions were granted for the establishment of metallurgical plants for the treatment of ores, the total mill capacity amounting to 655 tons per 24 hours. Apparently none were issued for the installation of smelters.

Mining contracts having for their object the purchase or transfer of mining property and the working of mines were recorded to the number of 825 in the Public Mining Registry, the money involved totaling 4,623,125.10 pesos. Likewise, 137 charters of mining companies were registered in the same office, their capitalization amounting to a total of 8,849,500 pesos.

Titles to 1,741 mining claims were cancelled by the Federal Government due to failure in the payment of mining surface taxes, but 387 cancellations were revoked: there is always the possibility for parties who are in default in their payment of mining taxes to recover their properties, provided they file a petition with the Finance Department in Mexico City (Secretaria de Hacienda y Credito Público) and the mining claims have not been re-denounced by other parties.

Mining claims to the number of 109 and covering a total area of 35,554 *pertenencias* were incorporated into the national mineral reserves. The total area of the States of Puebla and Oaxaca, as well as part of the States of Mexico, Guerrero, Michoacan, Colima, Jalisco, Veracruz, Hidalgo, and Querétaro, moreover, were declared a national reserve with respect to the exploitation of iron ores and coal. For the exploitation of salt a zone 5 kilometers wide along the shore line in Tamaulipas, Campeche, Yucatan, Chiapas, Oaxaca, Colima, Jalisco, Nayarit, Sinaloa, and Sonora was declared a national reserve. Within these zones nine concessions have been granted to cooperative organizations.

The tempo of mineral production in the Republic in the first nine months and of exports in the first eight months of 1935 is indicated in the data in Table I, issued by the Mines Department in Mexico City.

Table I—Metal Production and Export, in Kilograms

Metals	Production Jan. to Sept.	Exports Jan. to Aug.
Gold	16,448	5,977
Copper	30,699,303	30,776,758
Silver	1,770,020	11,598,010
Lead	133,396,864	138,353,398
Zinc	103,214,448	87,032,573
Antimony	2,969,384	2,499,962
Graphite	4,985,478	4,756,005
Quicksilver	164,658	129,885
Arsenic	8,151,790	7,357,329
Tin	520,927	453,240
Molybdenum	915,673	.....
Bismuth	166,327	.....
Cadmium	473,026	.....
Tungsten	46,591	.....

The production of silver in 1935 is compared with that of 1934 in Table II, the monthly average price of the metal for the latter year being given also.

Table II—Production of Silver in Mexico, 1934 and 1935

	Troy Ounces 1934	Troy Ounces 1935	Silver Price 1935, Dollars per Ounce
January	6,254,847	6,891,963	0.54418
February	5,412,999	6,639,843	0.54602
March	5,470,073	5,446,936	0.59048
April	6,847,427	5,581,127	0.67788
May	7,065,477	6,318,096	0.74356
June	6,461,378	6,377,304	0.71940
July	5,321,211	6,984,016	0.68216
August	6,536,095	5,858,461	0.66366
September	6,098,019	5,192,517	0.65375
October	6,820,848	5,842,638	0.65375
November	6,560,793	5,842,532	0.65375
December	5,614,129	7,449,427	0.58420

From the data in Tables I and II one may see that the high price of silver attained during 1935 did not increase the silver production in the quantities anticipated by the Mexican Government. This was undoubtedly due to the Federal decree of April 11, already mentioned, which levied the special heavy taxation on the metal.

Other Federal legislation enacted during 1935 included the following: Regulations dated March 19 were issued for the exploitation of national mineral reserve zones, such as referred to at the beginning. A decree was promulgated on May 14 authorizing the Secretary of National Economy to grant special concessions in favor of the cooperative organizations for working the saline lands situated within the zones of national reserve. Another decree, dated April 24, was issued, reopening the mining agency at Arteaga, in Michoacan; and finally a decree was rendered empowering the Secretary of National Economy to establish the most convenient basis for exploiting placer zones containing gold, tin, and platinum.

Several important investigations were conducted with a view to determining the possibilities of establishing treatment and metallurgical plants in several mining regions under a cooperative labor organization. The results of these investigations have not been published.

Cooperation of foreign engineers for the survey of mineral resources in Mexico has been welcomed by the Mexican Government. A group of geologists has just been engaged to study the possibilities of producing coal and iron in the State of Oaxaca. On the satisfactory result of this survey will depend the future action of the Government for the development of this region.

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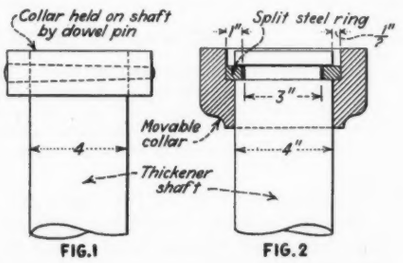
Thickener Shaft Repair

WHILE raising the shaft of an overloaded thickener to restore normal operating conditions at the Empire mill, Grass Valley, Calif., the dowel pin holding the collar to the shaft as in Fig. 1 was sheared off by the weight of the slime resting upon the rakes, and the thickener was rendered useless. At the time, the shaft was repaired in the conventional manner and the incident was considered closed until a similar breakdown occurred several weeks later, again necessitating cleaning out the tank and removing parts of the drive mechanism, with consequent loss of time and a temporary reduction in mill tonnage. It was then decided to alter



the end of the shaft containing the steel collar in such a way as to make a repetition impossible.

Phil Keast, mechanic in charge of maintenance work at the mill, solved the problem successfully, as shown in Fig. 2. This arrangement facilitates quick removal of the shaft proper and at the same time assures easy adjustment of the collar. The shaft is provided with a rectangular groove in which rests a split-steel ring locked by the movable collar. The lock mechanism can be removed by raising the shaft only a few inches and then taking the two halves of the ring out of the groove in the shaft.

What Is the Cost Of Mine Development?

• Examination of figures published for 90 different companies shows it to be a quarter of the total operating expense. . . . To meet it, management should set aside over a period of years this amount, of which a half to a third should be spent in prospecting for new ore to insure maintenance of reserves

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MINE DEVELOPMENT, as the term is now generally understood, comprises a wide variety of mine operations done for numerous purposes. These include shaft sinking; the driving of drifts, raises, and winzes; churn drilling, diamond drilling, and deep-hole drilling. Excavation of shaft and pump stations and sumps is usually considered a part of mine development. The purpose of development work is almost as varied as is its character, but two objectives are by far the most important. These are: (1) prospecting, or the search for new ore, and (2) extraction development, or the actual preparation of the orebody for mining. Other work which at times may be important is the driving of haulage or transportation drifts and raises, or ventilation drifts and raises.

Attempts are occasionally made to differentiate between prospect work and stope development work, and cost segregations are kept for each. Arbitrary rules are drawn up to fit the particular conditions at the mine and the wishes of the management. An example of such segregation is the method of charging intermediate drifting from stopes requiring waste fill. The first 30 ft. of any drift run into the wall may be charged to stoping on the theory that the stoping cost should include the cost of stope filling. When the drift has been extended for more than 30 ft. from the stope, it may be considered to have value for prospecting and from that point on it is charged to prospecting.

Another example of arbitrary segregation is afforded when a prospect raise is driving from a prospect drift. Such a raise is charged to prospecting as long as it is in waste. When it enters ore it is charged to stoping, and when it passes through the ore and enters waste it is charged to development. In other words, this raise is carried in three different accounts. Theoretically, there is justification for making each of such charges, but, practically, many complications and difficulties arise. If the raise passes through several strata of ore and waste, or if it is partly in ore, the particular account to which it should be charged is doubtful. Several of the larger companies have made attempts to determine costs segregated as described, but the results were usually not found to have sufficient value to justify the additional expense of getting them.

To avoid losing sight of the fact that development work, in most instances, includes prospect work, some companies call the account "Prospect and Development." Others use the caption "Exploration and Development," and still others, "Exploration." There is, of course, a difference in the meaning of the terms and the character of work which each represents, but to determine the cost of each class of development accurately usually adds an unwarranted expense. Most mining companies use the caption "Development" in their cost statements and include under it all kinds and types of prospecting, exploration, and development work. This term is used by the United States Bureau of Mines with the exception that the Bureau occasionally reports "development in ore" and "development in rock."

Examination of the costs of 90 mining companies shows that a very important part of their cost of mining is for current development. This relationship is true for the period of production, but does not reflect all of the development charges. The original development expense of opening up the mine, equipping it, and operating it until production starts, is not set up as a deferred expense and charged against current operations except in a few instances. The amount of this uncharged development expense is not ascertainable, but it is a very appreciable sum.

Greater variation occurs in development costs per ton than in the other costs of mining. This is due to the nature of the charge. In general, the development cost is made up of two parts, one of which is more or less fixed and the other variable. The stope development necessary to prepare a block of ground for extraction is a more or less fixed charge, whereas the amount of prospecting varies in accordance with the direction of the management. If the mine has ample ore reserves, excessive amounts of prospecting are not necessary and the total development charge is at a minimum. On the other hand, when reserves become low, a large amount of prospecting is done, with the result that the development cost becomes high. In mines which require waste filling, there is an incentive to encourage prospecting because of the need for the filling that results. However, this desire to get cheap filling may encourage the driving of a prospect drift which is located conveniently to the stope rather than some more worthy piece of work not so conveniently located. In a large operation where there are several mines or divisions, each in charge of a foreman, a keen spirit of rivalry nearly always exists as to who can show the lowest mining costs. The easiest way to reduce costs is to slight prospecting or to do it in the most convenient place or even in the most favorable ground for easy driving.

Wise management is always on the alert to prevent such practices. It was partly for this reason that nearly every large mining company in the Southwest, years ago, made a geological department a part of its organization.

Cost of development is dependent on the type and character of the orebody. Size, shape, regularity, width, height, length, and the physical characteristics of the ore and inclosing rock are the factors which determine development costs. These same factors determine the method of mining. It is therefore logical to consider costs of development by methods of mining.

In the accompanying tables, the essential cost data have been arranged according to methods of mining. The name and location of the mine are given; likewise the reference to the source from which the information has

Table I—Open-Stope Mining, Stope-and-Pillar Method Cost per Ton

Mine	Year	Tonnage	Total Mining	Development	Development % of Mining
No. 8, S. E. Mo.	1928	168,089	$0.886	$0.045	5
Tri-State No. 1	1928	68,770	0.985	0.049	5
Tri-State No. 2	1928	87,563	0.993	0.050	5
Tri-State No. 3	1928	132,384	1.001	0.030	3
Waco	1927–28	364,285	0.785	0.050	6
Bar	1929	90,688	0.862	0.047	5
Hartley-Grantham	1929	60,282	0.781	0.000	..
Hartley	1932	180,212	0.828	0.000	..

Table II—Details of Open-Stope Development Costs per Ton Glory-Hole or Mill-Hole Method

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Tota
Mascot, Tenn.	$0.028	.....	$0.004	.....	$0.015	.....	$0.006	$0.053
Mary, Tenn.	0.215	$0.020	0.054	.....	0.066	.....	.....	0.355
Burra Burra, Tenn.	0.149	.....	0.037	.....	0.043	.....	.....	0.229
Spring Hill, Mont.	0.219	.....	0.059	.....	0.089	.....	0.010	(a) 0.377
El Potosi, Mexico	0.092	0.006	0.026	$0.028	0.030	$0.003	0.017	(b) 0.202

(a) An extraordinary amount of development work was done during this period. (b) Includes diamond drilling.

Table III—Summary of Glory-Hole Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Mascot	I. C. 6239	1929	528,626	$0.639	$0.053	8	220
Mascot	A.I.M.E. Vol. 72	1923	212,990	0.784	0.133	17	83
Mary	I. C. 6397	1928	108,519	1.828	0.355	20	37
Burra Burra	I. C. 6149	1928	473,292	1.135	0.229	20	57
Ducktown No. 3	I. C. 6785	1928	.....	1.030	0.302	29	43
Spring Hill	I. C. 6402	1929	43,323	1.945	0.377	19	35
Sherritt-Gordon	C. I. M. & M. Bull. 257	1932	.....	1.304	0.327	25	40
El Potosi	I. C. 6804	1933	53,500	0.849	0.202	24	65

Table IV—Details of Development Cost at Open-Stope Iron Mines

(Cost per Long Ton)

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Marquette No. 1, Mich.	$0.107	$0.013	$0.045	.....	$0.031	$0.006	$0.016	$0.218
Marquette No. 2, Mich.	0.072	0.014	0.047	$0.047	0.018	0.006	0.047	0.251
Menominee No. 1	0.118	0.010	0.031	.....	0.039	0.009	0.004	0.211
Montreal Nos. 5 & 6, Wis.	0.213	0.018	0.077	.....	0.055	.....	0.004	(a) 0.427
Mineville, N. Y.	0.061	0.005	0.015	.....	0.021	.....	0.001	0.103

(a) Includes 6c. deferred rock development.

Table V—Summary of Iron Mine Development Cost per Long Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Marquette No. 1	I. C. 6138	1928	420,000	$1.412	$0.218	15	60
Marquette No. 2	I. C. 6179	1928	120,000	1.076	0.251	23	50
Menominee No. 1	I. C. 6180	1928	200,000	0.903	0.211	23	60
Montreal Nos. 5 & 6	I. C. 6369	1928	630,000	1.220	(a) 0.427	35	30
Mineville	I. C. 6092	1927	692,726	1.250	0.103	9	125

(a) Includes 6c. deferred rock development.

Table VI—Details of Development Costs per Ton—Miscellaneous Open-Stope Methods

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Mine B, Mich.	$0.129	.....	.....	$0.009	.....	.....	$0.059	$0.197
Mine C, Mich.	0.251	.....	.....	0.019	.....	.....	0.109	0.379
Rifle, Colo.	0.100	$0.010	$0.010	0.020	$0.040	.....	0.020	0.200
Teziutlan, Mexico	0.458	0.025	0.135	0.008	0.119	$0.068	0.113	0.926
Granada, Canada	0.423	0.049	0.254	.....	0.417	0.020	.....	1.163
Presidio, Tex.	0.759	.....	0.167	.....	0.117	.....	0.022	1.065

Table VII—Summary of Miscellaneous Open-Stope Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Mine B	B. of M. Bull. 306	1927	791,961	$1.129	$0.197	16	70
Mine C	B. of M. Bull. 306	1927	1,151,557	1.428	0.379	27	36
Rifle	I. C. 6662	1931	14,623	1.960	0.200	10	65
Teziutlan	I. C. 6736	1931	65,764	(a) 3.238	0.926	29	14
Granada	I. C. 6709	(b) 1932	3,104	5.014	1.163	23	11
Presidio	A.I.M.E. 1931	1929	54,524	4.001	1.065	27	12

(a) Includes some cut-and-fill stoping. (b) One month.

been obtained, the tonnage and year in which the ore was mined, the total cost of mining per ton, the cost of development work per ton, and the percentage that the cost of development is of the total cost of mining. In addition, the tons of ore per foot of development are calculated. To a large extent this latter figure is estimated. Some mining companies report their development in feet of shafts, drifts, crosscuts, raises, diamond drilling, and deep-hole drilling. Others report only the total footage of all classes of work. Many do not report any development on the basis of footage. Obviously, comparisons on the basis of the actual footage of the different kinds of work are impossible. The most satisfactory method of comparison is on money expended. A study of the cost of drifting (*Engineering and Mining Journal*, January, 1932) shows that about $13 per foot is a close average for mines located all over the United States. The item tons per foot of development is calculated on the basis of actual footage driven; otherwise the cost of development is converted into tons per foot of drifting on the basis of the known average cost of drifting or if the cost is unknown on the basis of a cost of $13 per foot. Although this method is not always accurate, it gives a fairly satisfactory basis of comparison obtainable in no other way.

Open-Stope Mining, Stope-and-Pillar Method—As employed in the Tri-State and southeast Missouri districts, the open-stope method of mining is the simplest and cheapest of all underground methods. In point of low costs per ton, it ranks second only to caving methods and one or two modifications of shrinkage. Its application in these districts not only results in low costs per ton but also requires the lowest initial capital expenditure for equipment. The development cost per ton is the lowest of all underground methods of mining. Table I shows the cost of mining and development at a number of these mines. The data have been taken from the United States Bureau of Mines Information Circulars.

From the cost given in Table I it is apparent that the cost of development amounts to approximately 5 per cent of the total cost of mining. The amount of development required is small, as the ore beds occur at shallow depths and are very extensive. Development work usually consists of a small untimbered shaft and sometimes a little drifting in waste rock. On the average, approximately 250 tons of ore are produced per foot of development work.

Glory-Hole Method—Glory-hole, mill-hole, and sublevel stoping are important modifications of the open-stope method of mining. Development costs at a number of these mines are shown in Tables II and III. These costs are representative of nearly 3,000,000 tons produced by eight mines.

From Tables II and III it is seen that the application of this method requires

that from 20 to 25 per cent of the mining costs be spent for development work. Over a considerable period of time one foot of development will probably produce from 40 to 50 tons of ore.

Open-Stope Iron Mines — Development costs of all the open-stope iron mines are grouped in Tables IV and V. This segregation does not conform to mining methods, as three of the mines used the glory-hole modification of open stoping. The production of these five iron mines was about 2,000,000 long tons of ore.

The costs in Tables IV and V show that at the open-stope iron mines from 20 to 25 per cent of the total mining cost is spent in development work and that each foot of work produces from 50 to 60 long tons of ore.

Miscellaneous Open-Stope Methods— A number of miscellaneous open-stope costs are shown in Table VI and VII. Methods of development vary considerably. At some of these mines the ore deposits are regular and continuous, whereas at others the reverse is true.

Although there is considerable variation in the character of the deposits covered by the figures in Tables VI and VII, with two exceptions the cost of development amounts to 25 per cent of the total cost of mining. The average for the group is 20 per cent. Three of these mines show 55 tons per foot of development and three about 12 tons per foot, or an average of 33 tons per foot.

Shrinkage Mining — Development costs of 21 mines using the shrinkage method are shown in Tables VIII and IX. These costs have been divided into three groups: (1) Narrow veins which vary from 4.5 to 12 ft. in width; (2) wide veins or medium-large oreshoots with widths over 15 ft.; and (3) large ore deposits such as the Alaska Juneau.

In narrow veins the development cost ranges from 14 to 42 per cent of the total cost of mining, with an average of 26 per cent. Average production per foot of development work for this group is 15 tons. The group including wide veins shows that the development cost amounts to 25 per cent of the total cost of mining and the production per foot of development is 42 tons. The large ore deposits have a development cost which amounts to 24 per cent of the total cost of mining. In this case, the production per foot of development amounts to about 125 tons. It is interesting to note that the ratio of the development cost to the mining cost for each of these groups is nearly the same and results in an average of 25 per cent.

Cut-and-Fill Method — Development costs at thirteen mines employing the cut-and-fill method of mining are presented in Tables X and XI. No attempt has been made to segregate them on the basis of the variation of the width of the vein or orebody. Usually, the deposits can be said to be wide, with widths of fifteen or more feet. The ton-

Table VIII—Details of Shrinkage Development Costs per Ton

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Narrow Veins (5-12 ft.)								
Nevada-Massachusetts, Nev.	$0.557	$0.012	$0.025	$0.092	$0.100	$0.036	$0.085	$0.907
Harmony, Idaho	0.320	0.190	0.030	0.020	0.090	0.050	0.050	0.750
Cortez-Silver, Nev.	0.774	0.061	0.180	0.046	0.191	0.036	0.139	1.427
Mogollon, N. M.	0.682	.....	.....	0.123	0.267	0.084	0.027	1.183
Hillside, Ill.	0.216	0.011	0.029	0.026	0.082	.....	0.019	0.383
Daisy, Ill.	0.582	0.082	0.162	0.034	0.210	.....	0.095	1.165
Teck-Hughes, Canada	0.167	0.030	0.050	0.077	0.091	0.005	0.013	(a)0.433
Kirkland Lake, Canada	1.490	0.100	0.380	.....	0.390	0.420	0.090	2.870
Vipond, Canada	0.362	0.044	0.128	.....	0.151	.....	0.043	(b)0.728
Wide Veins								
Mine D, Mich.	0.287	.....	.....	0.036	.....	.....	0.116	0.439
Mine No. 4, Mich.	0.126	0.011	0.029	.....	0.048	0.002	0.021	0.237
Engels, Calif.	0.266	0.021	0.054	.....	0.110	0.015	0.013	0.479
Mount Hope, N. J.	0.163	0.005	0.137	.....	0.055	0.014	0.028	0.402
Large Orebodies								
Alaska, Juneau	0.038	0.003	.....	.....	0.010	.....	0.010	0.061
East Bluff, Britain	0.024	0.005	0.009	0.005	0.022	0.015	.....	0.080
Alaska Gastineau	.....	.....	.....	.....	.....	.....	.....	0.130
Beatson	.....	.....	.....	.....	.....	.....	.....	0.290

(a) Does not include $0.071 per ton for diamond drilling and $0.612 per ton for sinking. (b) Includes $0.081 for diamond drilling.

Table IX—Summary of Shrinkage Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Narrow Veins (5-12 ft.)							
Nev.-Mass.	I. C. 6284	1928	40,924	$3.755	$0.907	24	14
Harmony	I. C. 6240	(a) 1929	19,000	3.140	0.750	24	20
Cortez Silver	I. C. 6327	(b) 1929	43,806	3.866	1.427	27	9
Mogollon	A.I.M.E. Vol. 72	1922	50,144	3.930	1.183	30	12
Hillside	I. C. 6294	1926	51,208	2.600	0.383	15	34
Daisy	I. C. 6384	1929	40,000	3.866	1.165	30	11
Smuggler, Colo.	*E. & M. J.* 3/31/28	1927	253,975	2.873	0.396	14	33
Ring Lease, Camp Bird	*E. & M. J.* Aug. '35	1934	25,000	3.130	0.940	30	14
Pony Express, Colo.	*E. & M. J.* Aug. '35	1934	8,000	2.240	0.620	28	20
Eighty-Five, N. M.	I. C. 6413	(b) 1930	7,220	5.490	1.040	18	13
Elkoro	I. C. 6543	1930	57,539	4.024	1.298	32	9
Teck Hughes	I. C. 6322	1929	29,810	4.186	(c) 1.116	28	12
Kirkland Lake	I. C. 6490	(b) 1930	4,108	6.760	2.870	42	5
Sylvanite	I. C. 6785	.....	.....	4.565	1.229	27	10
Vipond	I. C. 6525	1930	113,329	2.780	0.728	26	18
Wide Veins							
Mine D	B. of M. Bull. 306	1927	465,100	1.429	0.439	31	36
Mine No. 4	I. C. 6390	1929	(d) 117,224	1.432	0.237	17	55
Engels	I. C. 6260	1928	303,301	1.677	0.479	29	27
Mount Hope	I. C. 6601	1930	(d) 176,474	1.419	0.402	28	48
Large Orebodies							
Alaska Juneau	I. C. 6186	1928	3,670,910	0.297	0.061	20	210
Alaska Gastineau	A.I.M.E. Vol. 63	1915–18	6,523,873	0.601	0.130	22	100
Beatson	A.I.M.E. Vol. 76	1923–27	1,682,079	0.793	0.290	37	45
East Bluff	I. C. 6815	1933	398,664	0.514	0.080	16	162

(a) 5 months. (b) 1 month. (c) Includes diamond drilling at $0.071 per ton and shaft sinking, $0.612 per ton. (d) Long tons.

Table X—Details of Cut-and-Fill Development Costs per Ton

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
United Eastern, Ariz.	$0.279	.....	.....	$0.041	$0.097	$0.016	$0.068	$0.501
Mine E, Mich.	0.425	.....	.....	0.003	.....	.....	0.170	0.598
Champion, Mich.	0.297	$0.023	$0.069	.....	0.069	0.032	.....	0.490
Pecos, N. M.	0.677	(a)	(a)	0.014	0.131	0.099	.....	0.921
Colorado, Cananea	0.226	0.040	0.054	0.015	0.064	0.059	0.103	0.561
Matahambre, Cuba	0.334	0.060	0.067	0.009	0.105	0.077	0.059	0.711
McIntyre-Porcupine	0.405	0.016	0.021	0.025	0.159	.....	0.029	0.655

(a) Included with stoping.

Table XI—Summary of Cut-and-Fill Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
United Eastern	A.I.M.E. Vol. 76	1917–25	732,000	$4.271	$0.501	12	25
Mine E	B. of M. Bull. 306	1927	403,260	2.699	0.598	22	22
Champion	I. C. 6515	(a) 1929	193,597	2.528	0.490	19	25
Pilares	I. C. 6307	1929	643,000	2.600	0.399	15	25
Colorado	I. C. 6247	(b) 1929	142,006	2.411	0.561	23	23
Pecos	I. C. 6368	1929	81,827	4.512	1.218	27	11
Magma	I. C. 6168	1928	100,000	4.416	0.736	17	18
Elisa, Cananea	Personal	1926	96,472	4.010	0.720	19	17
Matahambre	I. C. 6145	1928	364,746	2.569	0.711	28	18
McIntyre-Porcupine	I. C. 6741	1931	557,104	3.073	0.655	21	20
Block P	I. C. 6416	1929	106,242	5.819	0.284	5	25
El Tigre	*E. & M. J.* 7/7/28	1927	80,570	6.420	1.810	28	7
Boise-Rochester, Idaho	I. C. 6823	(c) 1934	6,174	3.862	0.272	7	30

(a) 5 months. (b) 6 months. (c) 1 month.

Table XII—Details of Square-Set Development Costs per Ton

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Park Utah	$0.471	$0.029	$0.038	$0.004	$0.115	$0.070	$0.101	$0.828
Tintic Standard, Utah	0.692	0.074	0.196	.....	0.109	0.058	0.014	1.143
Silver King Coalition	1.210	0.073	0.382	0.004	0.313	0.091	0.013	2.086
Page, Idaho	0.720	.....	0.170	0.030	0.130	0.120	.....	1.170
Morning, Idaho	0.312	.....	0.031	0.019	0.044	0.036	.....	0.442
Hecla, Idaho	0.120	0.011	.....	.....	.....	.....	0.079	0.210
Magma, Ariz	0.502	0.044	0.046	0.023	0.059	0.062	(a)	0.736
Ground Hog, N. M	0.735	0.053	0.116	0.074	0.129	0.198	0.088	1.393
Pecos, N. M	0.677	(a)	(a)	0.014	0.131	0.099	.....	0.921
Victoria, Britannia	0.062	0.005	0.009	0.013	0.022	0.020	.....	0.131
Argonaut, Calif	0.139	.....	.....	0.011	0.011	0.001	0.003	0.165

(a) Included in stoping.

Table XIII—Summary of Square-Set Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Park Utah	I. C. 6290	1928	192,250	$4.662	$0.828	18	16
Tintic Standard, Utah	I. C. 6360	(a) 1929	8,758	9.484	1.143	12	11
Eureka Standard, Utah	I. C. 6851	1933	3,737	7.400	0.960	12	13
United Verde Extension, Ariz.	I. C. 6250	1928	275,890	4.290	0.611	14	21
Argonaut, Calif	I. C. 6311	(a) 1929	7,800	3.991	0.165	4	27
Morning, Idaho	I. C. 6238	1928	276,890	4.245	0.442	10	30
Hecla, Idaho	I. C. 6232	1928	312,942	3.297	0.638	19	20
Ground Hog, N. M	I. C. 6377	1930	11,146	3.990	1.393	35	10
Silver King Coalition	I. C. 6371	1929	180,208	7.745	2.086	27	6
Victoria, Britannia	I. C. 6815	1933	133,195	1.768	0.131	7	60
Page, Idaho	I. C. 6372	1928	90,460	3.820	1.170	31	19
Magma, Ariz	I. C. 6168	1928	263,094	4.578	0.736	16	17
Pecos, N. M	I. C. 6368	1929	217,121	5.422	1.218	22	16
Copper Queen, Ariz	I. C. 6691	1930	725,409	.....	0.900	..	14
Anaconda, Mont	I. C. 6691	1926–27	.....	.....	.....	..	16
Central Eureka, Calif	I. C. 6512	(a) 1929	.....	.....	.....	..	18

(a) 1 month.

Table XIV—Details of Top-Slice Development Costs per Long Ton

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Marquette No. 2	$0.072	$0.014	$0.047	$0.047	$0.018	$0.006	$0.047	$0.251
Marquette No. 5	0.032	0.002	0.005	.....	0.007	0.003	0.003	0.052

Table XV—Summary of Top-Slicing Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Mesabi	I. C. 6325	1928	(a) 209,300	$1.165	(b) $0.000	..	..
Marquette No. 2	I. C. 6179	1928	(a) 240,000	1.366	0.251	18	52
Marquette No. 5	I. C. 6380	1929	(a) 555,919	1.095	0.052	5	200
Miami, Ariz	A.I.M.E. Vol. 55	1916	4,500,000	0.880	0.140	16	93
Veta Grande, Cananea	I. C. 6247	1929	42,565	2.197	0.323	15	35
Oversight, Cananea	Personal	1916	155,000	2.300	0.340	15	34

(a) Long tons. (b) Curtailed production and only a small amount of development charged to stoping.

Table XVI—Summary of Block-Caving Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Miami, Ariz	Report	1930	6,124,993	$0.399	$0.100	25	200
Inspiration, Ariz	I. C. 6169	1928	4,879,646	0.740	0.211	29	90
Ray, Ariz	I. C. 6167	1928	3,243,159	0.840	0.146	18	100
Morenci, Ariz	I. C. 6107	1928	1,548,258	(a) 0.800	(a) 0.199	25	90
Ruth, Nev	*E. M. & J.* 11/7/25	1924	850,000	1.320	0.300	23	70
Braden, Chile	I. C. 6565	1928	5,174,017	0.484	0.046	10	280

(a) Estimated.

Table XVII—Details of Development of Sublevel Caving Method

Mine	Labor	Supervision	Air Drills, Steel	Power	Explosives	Timber	Other Supplies	Total
Eureka-Asteroid	$0.197	$0.011	$0.043	.....	$0.059	.....	$0.007	$0.317
Montreal No. 4	0.105	0.007	0.052	.....	0.025	.....	0.005	(a) 0.254

(a) Includes 6c. per ton deferred expense.

Table XVIII—Summary of Sublevel Caving Development Costs per Ton

Mine	Reference	Year	Tons	Total Mining	Development	Development % of Mining	Tons per Foot of Development
Eureka-Asteroid, Mich	I. C. 6348	1929	(b) 401,680	$1.537	$0.317	20	50
Montreal No. 4, Wis	I. C. 6369	1928	(b) 450,000	1.339	(b) 0.254	19	60

(b) Long tons.

nage on which these costs are based amounts to about 3,500,000 tons.

Eliminating from the average two mines whose costs are definitely out of line, it is found that the development costs amounts to 21 per cent of the total cost of mining. On the same basis the production per foot of development is about 19 tons.

Square-Set Mining—Data relative to the development cost at fifteen mines using the square-set method are shown in Tables XII and XIII. The production of these mines amounts to about 2,500,000 tons.

Conditions at the square-set mines vary greatly, but in spite of this fact there is a greater variation in development costs than can be accounted for by the operating conditions. A part of the difference is undoubtedly due to the method of distributing costs. Omitting the Argonaut and Victoria mines from the average, the other mines show that development amounts to about 20 per cent of the total cost of mining and the production is about 18 tons per foot of development work.

Top-Slice Method — Development costs at two iron mines and three Western copper mines are shown in Tables XIV and XV. The iron mines produced about 1,000,000 long tons of ore. No development work was charged against the Central Western Mesabi mines, as the output was considerably curtailed during 1928 and the small amount done was charged to stoping.

Development costs of top-slice mines amount to about 16 per cent of the total cost of mining and the production per foot of development work is about 60 tons.

Caving Methods—Caving methods of mining are represented by costs from eight mines, six of which are block-caving and two of which are sublevel caving. These costs are shown in Tables XVI, XVII, and XVIII. The total tonnage produced amounts to 22,000,000 tons.

Development costs of the Miami and Ray mines are determined on the basis of a deferred or suspense account. At Miami the cost is 10c. per ton and for Ray it is 14.6c. per ton. Morenci's development cost is based on the cost of mining a block of ore with a thickness of 145 ft. and containing 120,000 tons.

Table XIX—Summary of Development Costs by Methods

	Development Per Cent of Mining	Estimated Tons per Foot of Development
Open Stope		
Room-and-pillar	5	250
Glory hole	23	45
Iron mines	23	55
Miscellaneous	20	23
Shrinkage		
Narrow veins	26	15
Wide veins	25	42
Large deposits	24	125
Cut-and-fill	21	19
Square-set	20	18
Top-slice	16	60
Caving		
Block caving	25	100
Sublevel caving	20	55

The most important single factor in controlling the development cost of block caving is the height of the column of ore to be caved. It is evident that the gross amount of development for caving a block of ore is nearly the same when the vertical height is 100 or 200 ft. When this development can be distributed over the double tonnage as represented by the 200-ft. thickness the cost per ton is reduced by 50 per cent. The development cost of Braden is so much less than at the other mines that it is not comparable. It probably does not include some prepaid development and is, therefore, omitted from the average. The Miami, Inspiration, Ray, and Ruth mines show development costs which amount to 25 per cent of the total cost of mining. About 100 tons of ore are produced per foot of development.

The two sublevel caving mines cited in the data given show a development cost of 20 per cent of the total mining cost. Production per foot of development is approximately 55 tons.

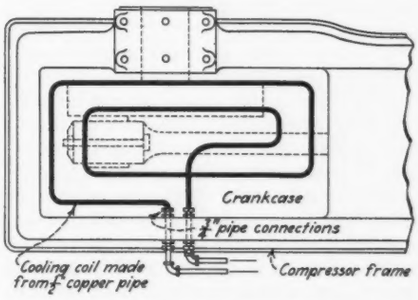
A summary of the various development costs is given in Table XIX. The reader will see that development costs range from 20 to 25 per cent of the total cost of mining. Attention should be drawn to the items which these costs include. As already stated, cost sheets seldom distinguish between that work which is essentially prospecting or the search for new ore and the development work which is required for the extraction of ore already discovered. In the block-caving mines, most of the cost represents development for ore extraction. In most cases these orebodies were discovered by a comprehensive campaign of churn drilling, which is not charged to current development and may or may not be included in a suspense account. In the Tri-State district, a very small amount of development cost represents the search for new ore. The orebodies were originally discovered by drill holes or by shallow prospect shafts. In some of the iron mines and also in some of the top-slice mines the cost of discovery is not included in the costs as given. The same fact applies to the large shrinkage mines. The costs of cut-and-fill, square-set, and small shrinkage mines in many instances include current prospect work.

Estimates have been made of the cost of the extraction development necessary to mine a given block of ground by the square-set, the cut-and-fill, and shrinkage methods. In a large number of the copper mines in the Southwest it is probable that two-thirds of the development cost represents prospecting. This relationship would apply to a great many mines such as the Copper Queen, Calumet & Arizona, Old Dominion, United Verde, United Verde Extension, Cananea, and Nacozari. In normal times, most of these mines drive a mile or more of underground workings per month. The total amount of development work done at any of these mining camps is from a hundred to several hundred miles. In addition to this, in some instances, diamond drilling is an important aid to ore discovery, and in several of the mines mentioned, deep-hole drilling plays its part; and in one case churn drilling has materially added to ore reserves.

To make any study of practical value, it is desirable, if possible, to draw definite conclusions. From Table XIX we see that with two exceptions development amounts to from 20 to 26 per cent of the total cost of mining, with an average of 23 per cent. To allow for items that were obviously development but which were charged to some other account, this figure is increased to 25 per cent. The conclusion drawn is that of the total direct operating cost of mining, 25 per cent should be set aside over a period of years for development, of which, in most cases, one-half to two-thirds should be spent for prospecting for new ore. With the exception of the large porphyry mines, in general, if such an amount is not spent, the chances are that ore reserves are being depleted. One should bear in mind that this figure applies only to current mine operations and does not include the original prospecting and development expense of opening up the mine, equipping it, and carrying on operations to the point when production starts. Quite possibly, if the original capital expense for development were taken into consideration, the true cost of development on the average would amount to 35 to 40 per cent of the cost of mining.

Cooling Coil Reduces Oil Temperature In Compressor Crankcases

HIGH TEMPERATURES during the summer months caused considerable trouble at the compressor house of the Empire-Star Mines Company, Grass Valley, Calif., writes Phil Keast, mechanic in charge of maintenance work at Empire mine. The period between 10 a.m. and 3 p.m. in particular proved to be trying, for the temperature of the lubricating oil in the crankcases of the compressors rose to such a point as to make proper lubrication impossible. Hot bearings often resulted, and the machines operated noisily. Several schemes, including the use of a fan, were tried to remedy this difficulty, but all proved either inadequate or too costly. Ultimately, the only practical way advisable was to find means to cool and keep at an even temperature the oil stored in the deposit provided in the crankcase. This was accomplished successfully by placing a copper pipe coil within the oil storage deposit, as shown in the accompanying sketch.



Detail of cooling installation

The coil, made from ½-in. copper pipe, is attached to the wall of the compressor frame by two special ¾-in. connections, each consisting of a spud and nut, which also serve as the inlet and outlet connection for the cooling water. With the described installation, the temperature of the diverse bearings is kept well below the critical point, and continuous service is thus assured.

●

Inlet Valve Lever Repair

SUDDEN BREAKAGE of an inlet valve lever on a 150-hp. diesel engine recently caused considerable concern at the power plant of a mining company operating a small gold mine and mill in a remote region in central Peru, South America. The engine was the main source of power supply, and, with the mine making considerable water, a shutdown until the arrival of a new lever was out of the question. Consequently, a quick repair of the broken lever was the only method by which the difficulty could be overcome. In view of the absence of an expert blacksmith and lack of a welding outfit, the damaged lever was repaired in the manner shown in the accompanying sketch. A new fork was made from mild steel, which was first fitted and then secured to the squared sides of the center portion of the level proper by six countersunk screws. Total time required to make the repairs was 4½ hours.

Method of repairing valve

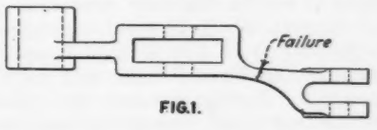


FIG.1.

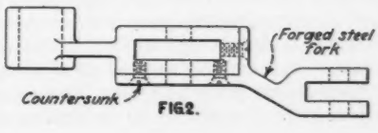


FIG2.

TOM REED MILL, at Oatman, has increased its capacity to 300 tons by addition of ball mill and classifier. About 90 per cent of the ores received are custom ores

TELLURIDE CYANIDE MILL treats gold ore produced at the Old Western mine, at Oatman, which is hauled by truck to the mill. Capacity is 50 tons per day

Renewed Mining Interest at Oatman

Rehabilitation of old mines revives historic gold camp

John B. Huttl

Assistant Editor

THE RESILIENCY of the Western mining industries and their innate vitality are well illustrated by the current activity in the historic Oatman area. Declared to be worked out on several occasions, ravaged by two fires, and then passing through a period of decreased activity until 1933, the camp has more than held its place as a gold producer since enhancement of the price of gold to $35. Though no new orebodies have been discovered in recent years, gold production has increased steadily since 1934. At present, activities are centered in opening up orebodies found unprofitable at $20.67 gold and mining gold impregnations or quartz outcroppings by trenching and glory-hole methods. Good roads and abundant electric power at reasonable rates have also played their part in the revival of mining operations at Oatman.

The Oatman district covers an area of about 10 miles long by 7 miles wide on the western slopes of the southern part of the Black Mountains in western Mojave County, Ariz. Oatman, the principal settlement, is 29 miles southwest of Kingman, and can be reached over United States Highway 66. Numerous short gravel roads lead from this highway to the individual claims and mines, most of them worked by leasers. Nearly 400 men are employed in the district, which boasts a production record of more than $36,000,000, according to State Mining Bureau figures.

Tom Reed Gold Mines Company continues to be the dominant enterprise in the district. W. B. Phelps is managing the property, with Jack Zwinge as superintendent and Paris Brough, mill superintendent. During the past two years the company has unwatered and retimbered the Ben Harrison shaft with a view of reopening the lower levels, where a considerable tonnage of ore is known to exist that can be worked at a profit at the present price of gold. The shaft is now in good condition to the 600 level, the ultimate goal being the 900 level, to facilitate sampling and exploration of ground between this and the 500 level. On the 500 level a 1,000-ft. exploratory drift is being extended another 1,000 ft. into virgin territory south of the Ben Harrison shaft. Development work undertaken some time ago in the Black Eagle, Aztec, and United American properties—the latter leased to the company—was stopped recently because of unsatisfactory results, and work there is confined to clean-up operations. Ore hoisted to the surface is transported to the mill over an aërial tramway. Other holdings are worked by leasers. The ore mined on company account constitutes about 20 per cent of the tonnage treated at the mill.

The cyanide mill, remodeled about two years ago, is now operated as a custom plant. Early in February the company completed the installation of a new 6x6-ft. Allis-Chalmers ball mill and a Dorr Multizone classifier to take care of increased ore shipments and provide for more continuous operation. The mill contained only one primary ball mill, and as a consequence the average daily tonnage milled was irregular for the reason that the feed varied considerably in hardness from day to day, apart from the fact that repairs to the mill meant complete cessation of operations. This difficulty has been overcome by the addition of the new grinding equipment described. At present the daily tonnage of ore milled is up to the settling capacity of the primary thickener, which is somewhat more than 250 tons in cold weather and 300 tons during the summer months. Recent experiments with caustic starch solution as a slime flocculator have resulted in improvements which have helped increase the milling capacity close to 300 tons a day even in cool weather. Reduction of lime consumption is now planned, as one pound of lime per ton solution in the primary circuit is considered excessive with a flocculator such as starch, which is added only in minute quantities.

Operations at the mill are graphically explained in the accompanying flowsheet. Grinding is done in two stages by ball mills operating in closed circuit with Dorr classifiers. The discharge from the primary mills, however, can be sent direct to the classifiers in the secondary grinding circuit whenever the ore treated requires such a change. In general fine grinding is necessary to part the finely grained gold particles from the gangue. From 70 to 90 per cent of the overflow from the secondary classifiers passes through 200 mesh. Assays of tailing screen sizes are given in the accompanying table.

To provide for a longer agitation period, the company plans to install another 40x12-ft. agitator. The present period is about 50 hours.

Consumption of materials is as follows: 5-in. balls, 1.83 lb. per ton; 2½-in. balls, 2.20 lb. per ton; Aerobrand 48 per cent cyanide, 1.50 lb. per ton; lime, 4.05 lb. per ton; zinc dust, 0.543 lb., 0.151 lb. per ton of solution precipitated, and 0.57 lb. fine ounce of bullion, respectively. Mill feed averages $13.303 gold and 0.796 oz. silver. Tailings average $0.64 gold and 0.237 oz. silver. Solution tailings assay $0.06 gold and 0.005 oz. silver, and milling costs are about $2 per ton of ore treated, including indirect charges.

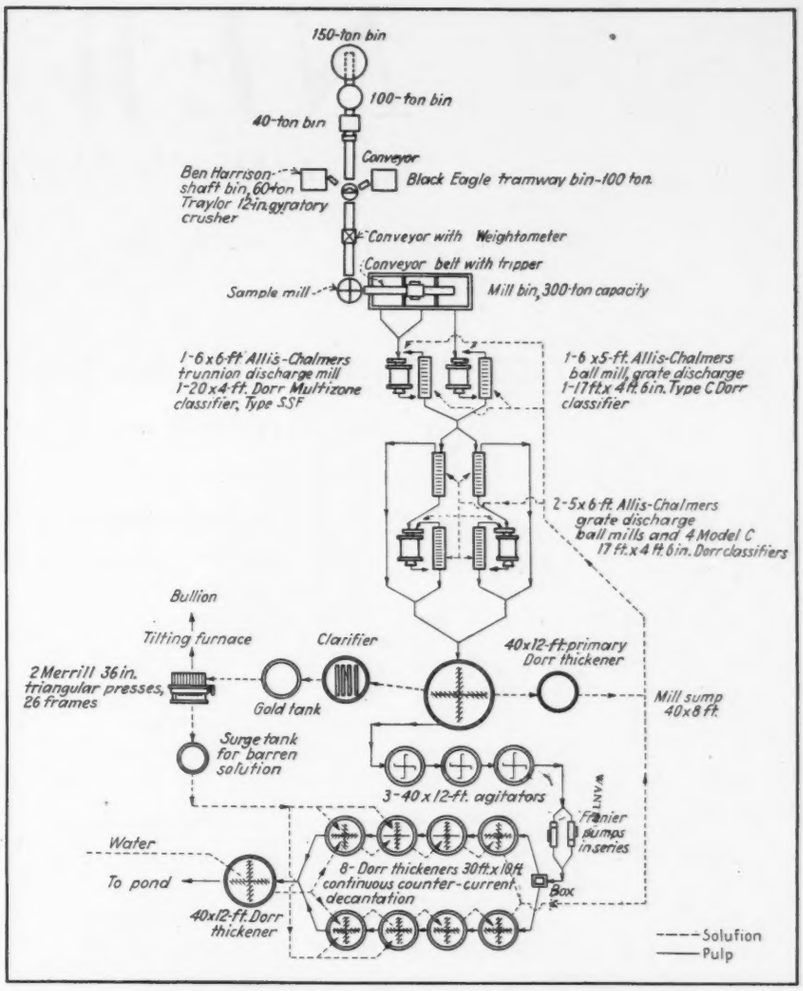
Few changes have been made at the sampling plant. It contains a 60-in. Snyder sampler taking a 10 per cent cut of 2-in. material and smaller at the conveyor discharge; a 15x9-in. Blake crusher set to crush from 2 in. to ½ in. at about 5 tons per hour; a 27-in. Snyder sampler taking a 10 per cent cut of ½-in.

material; a set of 18x10-in. crushing rolls to reduce the ½-in. material to ⅜ in.; a 27-in. Snyder taking a 10 per cent cut of ⅜-in. material; a set of 8x5-in. rolls reducing 200 lb. per hour from ⅜-in. product to 16 mesh; and a 6-in. bucket elevator for returning cutter rejects to the distributing belt. All are driven by a 25-hp. motor. Jones dividers and Braun pulverizers are used for further splitting and reduction.

Samples containing excess moisture are dried first on hot plates to obviate caking in the second set of crushing rolls. Two 10-lb. samples from each lot of ore treated in these rolls are riffled on a Jones divider, one sample being held at the mill and the other sent to the assay office to be ground to pass through a 100-mesh sieve. Here it is rolled for 30 min. and spread in a thin layer over a 30-in. circle. Small dips are then taken in concentric rings with a 5-in. spatula. Dip spacing is about 1 in. for the first control sample. Each successive control is the product of staggering dips between the previous ones. Six controls are prepared for each lot of ore, one control for the buyer, one for the shipper, and a third for possible umpire. The remaining controls are held for a possible dispute. Umpires are sent to several reputable Western firms. Moisture determinations are made on each sample immediately after completion of the run, and settlement is made on the basis of dry tonnage.

Custom ore is supplied by about 100 shippers. The largest monthly shipment is 1,500 tons from the Gold Road mine, operated by the United States Smelting, Refining & Mining Company, which is followed by 1,000 tons from the Oatman Eastern properties, 800 tons from the Pioneer group, and 800 tons mined by company leasers. All ore is trucked to the mill and stored in steel bins erected recently.

The second milling project in the district is the old Telluride cyanide plant about ½ mile west of the Aztec mine. This mill and the Western property at Oatman are operated by Johnston and Witcher. Ore from the Western mine is trucked to the mill and crushed to 2 in. in a 12x16-in. Blake crusher before going over an incline conveyor equipped with a Merrick Weightometer to the mill bin. Grinding to 75 per cent minus 200 mesh is done in a 6x4½-ft. Marcy mill with a Dorr classifier, the pulp going direct to the 50-ton counter-current cyanide plant. Mill heads average $14 per ton. C. M. Broyles directs operations at the mill. The Telluride mine and the adjoining Red Lion property are idle at present.


150-ton bin
100-ton bin
40-ton bin
Conveyor
Ben Harrison-shaft bin, 60-ton Traylor 12-in. gyratory crusher
Black Eagle tramway bin-100 ton
Conveyor with Weightometer
Conveyor belt with tripper
Sample mill
Mill bin, 300-ton capacity
1-6 x 6-ft. Allis-Chalmers trunnion discharge mill 1-20 x 4-ft. Dorr Multizone classifier, Type SSF
1-6 x 5-ft. Allis-Chalmers ball mill, grate discharge 1-17 ft. x 4 ft. 6 in. Type C Dorr classifier
2-5 x 6-ft. Allis-Chalmers grate discharge ball mills and 4 Model C 17 ft. x 4 ft. 6 in. Dorr classifiers
Bullion
Tilting furnace
Clarifier
40x12-ft. primary Dorr thickener
2 Merrill 36 in. triangular presses, 26 frames
Gold tank
Mill sump 40x8 ft.
Surge tank for barren solution
3-40 x 12-ft. agitators
Pachuca
Frenier pumps in series
Water
To pond
8-Dorr thickeners 30 ft. x 10 ft. continuous counter-current decantation
Box
40x12-ft. Dorr thickener
Solution
Pulp

FLOWSHEET OF TOM REED 300-TON CUSTOM MILL

About 1½ miles southwest of Oatman is the Pioneer property, formerly known as the German-American. An interesting situation prevails here. The mine is worked by about 30 sets of leasers comprising 85 men—all unemployed miners who refused to go on relief—under the direction of George Moser, representative of the owners. Most of the ore is mined from surface workings, but several leasers have installed hoisting facilities and are now developing oreshoots at depth. Production during recent months averaged 800 tons per month, which is trucked to the Tom Reed mill. Activities at the neighboring Gold Dust mine are confined to underground development work, with fifteen men employed.

The Gold Road mine, about 1½ miles northeast of the Tom Reed property, is shipping from 1,200 to 1,500 tons of ore a month. Underground, a comprehensive development program is being carried out under the direction of L. H. Duriez, resident manager. Improvements made at the surface plant include a new headframe, a storage bin, and several buildings. Plans are maturing for the erection of milling facilities and expanded activity in the late spring. Exploratory work conducted from the original discovery shaft is in progress at the United Eastern holdings.

The near-by Silver Creek district is quite active. Oatman Eastern Mining Company is developing at depth its Ruth-Rattan holding and is shipping 800 tons of ore a month to the Tom Reed mill. Several large, low-grade orebodies have been opened up recently in the district, and mining men are watching with interest further developments. Apart from the Oatman Eastern operations directed by J. J. Moss, president, several leasers are active, making regular shipments to Tom Reed.

Assay of Tailing-screen Products at Tom Reed Mill

Mesh	Per Cent	Value (Gold $35)	Distribution	Per Cent of Total
Plus 100 sand	1.32	$2.45	$0.0323	4.32
Plus 150 sand	7.35	1.22	0.0896	11.98
Plus 200 sand	16.09	1.05	0.1689	22.59
Minus 200 sand	17.89	0.87	0.1556	20.82
Minus 200 slime	57.35	0.525	0.3010	40.27
	100.00		$0.7474	99.98

NEWS
OF THE INDUSTRY

American Zinc Institute Finds the Outlook For the Industry Promising

Increased Consumption of Galvanized Products Creates Wider Demand for Prime Western Metal

THE eighteenth annual meeting of the American Zinc Institute, held in St. Louis on April 20 and 21, had an attendance surpassing that of previous years, and the occasion was marked by reports indicating that the zinc industry was not only participating in the general industrial improvement, but the merits of the metal were becoming better known and applied in wider fields of usage.

The morning session on April 20 was presided over by President Howard I. Young, and the address of welcome was made by T. N. Dysart, president of the St. Louis Chamber of Commerce. John A. Robinson, president of the Tri-State Zinc and Lead Producers Association, responded. The activities of the American Zinc Institute were described by Ernest V. Gent, who said that many inquiries from numerous directions were being received about the various uses of zinc, and that the Institute was compiling statistics vital to the industry. It was pointed out that the solvency of the farmer is better than that of workers in other industries, and with a higher purchasing power scattered among the 6,000,000 farms of the country, consumption of zinc has increased, due to sales of galvanized products for farm use. A feature of the meeting was a demonstration by two students showing how the Institute is circulating educational information about galvanized products in farming communities.

Matters of importance to the zinc industry, such as taxation, labor legislation, and business regulation, were reported on by Julian D. Conover, secretary of the American Mining Congress. He said that the efforts by the Labor Relations Board clearly indicate that they are trying to establish the view that mining and industrial operations function as "one giant indivisible economic process" in interstate commerce, and should be, therefore, subjects for Federal regulation. The Social Security Act, the Holding Company Act, and other legislative measures were described and their present status was mentioned. An analysis of the proposed new taxes in the latest revenue bill shows that the measure would have a tendency to penalize the smaller mining enterprises, which require current earnings for development and expansion.

In discussing the labor bills now proposed, calling for regulation of wages and hours in connection with Government contracts, it was pointed out that as far as the mineral industry was concerned, records show that wages are being maintained as high as is economically possible. Proposed laws regulating business practices, such as the Wheeler anti-basing point bill and the Patman bill, and their effect upon the zinc industry, were analyzed. It is generally thought that if either of these laws should be enacted, the St. Louis method of quoting zinc, which, in a large measure, includes the freight-rate structure, would have to be abandoned. In its place would be a method by which the buyer would have to use a system wherein there would be numerous different quotations, depending upon the destination of the product bought, and whether it was zinc ore, High-Grade zinc, slab zinc, or zinc products, all of which are now commonly sold on a delivered-price basis.

H. B. Meller, managing director of the Air Hygiene Foundation of America, said the chief problems of silicosis were the determination of the prevention of the disease in the early stages, the determination of concentrations of dust most dangerous, and the continued development of preventive measures. He stressed the importance, to all industries affected by this disease, of eliminating the silicosis racket which has so viciously fought corrective measures in combating the disease. He said that the best way for industry to protect itself against dust hazards was to unite behind a broad program whose purpose is the selection and evaluation of known facts, not only of silicosis but of kindred industrial diseases. He urged the support of scientific research in cause and effect of this disease as well as its prevention. Another speaker in the afternoon session was C. S. J. Trench, president of C. S. Trench & Company, New York, who discussed the zinc market, and said that the market will take care of itself if a sensible balance between supply and demand is maintained in the industry.

Modern research carried on in centralized laboratories was advocated by Clyde E. Williams, director of the Battelle Memorial Institute, Columbus, Ohio. The development of new products through research is of greater importance to industry than cost reduction, and Mr. Williams thought all metal industries should cultivate the practice of centralized industrial research laboratories such as are carried on abroad, where such research is found in more advanced stages than in this country.

The guest speaker at the annual dinner and smoker was T. M. Girdler, president of the Republic Steel Corporation. He pointed out that the outlook for the steel industry is particularly bright if the natural forces of recovery

H. I. Young to Serve For Another Year

OFFICERS elected for the ensuing year by the American Zinc Institute at St. Louis were: Howard I. Young, of the American Zinc, Lead & Smelting Company, president; C. Merrill Chapin, of New York; J. O. Elton, of Salt Lake City; and John A. Robinson, of Miami, Okla., vice-presidents; James A. Castleton, of St. Louis, treasurer; and E. V. Gent, of New York, secretary.

now under way are permitted to operate. He said, "American industry is staging a comeback which will go far unless blocked by unsound legislation based on the theories of academic nonproducers. Big depressions always give rise to fantastic economic ideas and theories. We have had a great outcropping of quacks. They all advocate some sort of rearrangement of our economic system."

The concluding session of the meeting was devoted to problems and practice in the galvanizing industry. Among the subjects and the speakers were: "Some Studies in Microstructure of Zinc Coatings," by W. E. Buck, research metallurgist, Granite City Steel Company; "Testing for Adherence of Galvanized Coatings," by B. P. Finkbone, galvanizing consultant, American Rolling Mill Company; "Inhibitors in Pickling," by P. R. Russell, steel service division, The Grasselli Chemical Company; "Alloys in Zinc Bath," by G. A. Brayton, superintendent, galvanizing division, Newport Rolling Mill Company; "The Treatment of Galvanized Sheets for Painting," by J. L. Schueler, superintendent, steel and wire division, Continental Steel Corporation; and "Sweating of Sheets in Transit and Storage," by G. C. Bartelli, field engineer, American Zinc Institute.

Utah Experiment Station Offers Fellowships

FIVE research fellowships and one teaching fellowship are offered by the Utah Engineering Experiment Station for the year 1936-37, and are open to college graduates who have had the proper training in mining, metallurgy, chemistry, or geology.

The research fellowships carry stipends of $300 each. Holders may be required to spend a maximum of four hours weekly assisting in the Station. The teaching fellowship carries a stipend of $500. A maximum of twelve hours a week assisting in the Department of Metallurgy is required. All fellowshipmen are exempt from tuition and all fees except the graduation fee of $10 and laboratory fees in courses taken outside the department.

The subjects in which research work will be conducted include: Mine ventilation, ore dressing, ore dressing microscopy, physical-chemical investigations of flotation phenomena, hydrometallurgy, pyrometallurgy, thermodynamic properties of compounds of metallurgical importance, and bituminous coal research.

Applications will be received until May 15, 1936. Application blanks may be obtained by addressing: The Director, Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah. Each applicant should have an official transcript of his college record sent to the Station and at least three references.

Silicosis Conference Sponsored By Department of Labor

Representatives of Mining, Labor, Insurance, and Industrial Organizations, and Public Health Officers Meet for General Discussion—Four Committees Appointed to Study and Report on Major Phases of Problem

ABOUT 150 representatives of the mining industry, industrial and labor organizations, insurance companies, and health officials met in Washington, D. C., on April 14 to consider the hazard of silicosis in dusty industries and to organize a program of investigation directed toward prevention and control of this menace to health. Among those representing the metal mining industry were John Wellington Finch and Dan Harrington, of the Bureau of Mines; Felix E. Wormser, Lead Industries Association; Ernest V. Gent, American Zinc Institute; H. Y. Walker and Wilfred McFarland, American Smelting & Refining Company; and Julian D. Conover, American Mining Congress. The United States Public Health Service was represented by Surgeon R. R. Sayers.

Three of the conferees on silicosis. In the center is Secretary Perkins of the Department of Labor. At the left is Dr. R. R. Sayers, of the United States Public Health Service, for years detailed to the United States Bureau of Mines as its Chief Surgeon. At the right is John Frey, President of the metal trades department of the American Federation of Labor

The principal outcome of the meeting was the appointment of four committees to study the prevention of silicosis through medical and engineering control, and to investigate the economic, legal, insurance, regulatory, and administrative phases of the silicosis problem. It is expected that committee work will require four or five months and that the results will be reported at a future conference.

In opening the meeting Secretary Perkins reviewed the industrial situation with respect to silicosis, and the relation of the Department of Labor to the subject. The Department's function is to promote improvement in the industrial conditions of workers, in an advisory capacity only and with no regulatory authority. In her judgment fully 500,000 workers are exposed to the hazard of silicosis, and it is highly important for those interested in the prevention of industrial diseases to pool their knowledge on this subject and take steps to control the contributory causes. She recognized the evil of damage suits for disability, and expressed the opinion that this aspect of the problem can best be met by making silicosis a compensable disease under workmen's compensation laws.

Need of Research Emphasized

Surgeon Sayers spoke on the medical aspects of silicosis, dwelling at some length on the scientific work of the Bureau of Mines and the Public Health Service. Probably more than any other man in the medical profession he has made extensive investigations in the mining and other industries and is familiar with existing conditions and methods of control. In spite of the extent of our present knowledge, there is much to be done in the field of research. Dr. Sayers emphasized the

necessity of physical examination of workers and close cooperation between members of the medical and engineering professions in devising adequate means of controlling the disease. In his opinion 1,200,000 persons are working under conditions that expose them to silicosis. As they shift from one industry to another, it is highly desirable for employers to get a complete history of their health, particularly with respect to respiratory diseases. Together with physical examinations those records are of incalculable value for the protection of both employer and employee.

Representing the recently organized Air Hygiene Foundation, Pittsburgh, A. C. Hirth directed his remarks mainly to employers' problems with respect to silicosis. He supported Dr. Sayers's contentions on the necessity of physical examinations and the establishment of competent medical boards to determine the extent of alleged disability from silicosis. He deplored the practice of leaving such matters to courts and juries which are incompetent to pass on these complex technical questions. On the subject of legislation he pointed out the danger of hasty action, lest more harm than good be done. New York State offers a typical example, in which silicosis was first made compensable under an all-inclusive amendment to the Workmen's Compensation Act. Employers were at once confronted with staggering insurance premiums and employees were threatened with loss of jobs. A new bill drastically limiting compensation is now before the Legislature. Mr. Hirth felt that something must be done to abate the nuisance of racketeering suits, but that the greatest care should be exercised in legislation on the subject. He advocated widespread publicity on the truth about silicosis, so that the public would be better informed and not harbor misconceptions about the disease, its cause and control.

In the proposed committees to study various phases of the silicosis problem, the mining industry is represented by Dan Harrington and W. P. Yant, of the Bureau of Mines. The personnel of the committees follows:

Prevention of Silicosis Through Medical Control: Surgeon R. R. Sayers, United States Public Health Service, Chairman. Dr. J. H. Chivers, Crane Company; Dr. L. U. Gardner, Saranac Laboratories; Wesley Graff, National Bureau of Casualty and Surety Underwriters; Thomas Kennedy, United Mine Workers of America; Dr. A. J. Lanza, Metropolitan Life Insurance Company; Dr. W. S. McCann, Strong Memorial Hospital; Dr. E. P. Pendergrass, University of Pennsylvania; Dr. B. L. Vosburgh, National Electrical Manufacturers Association; Dr. C. H. Watson, National Safety Council; and Dr. J. Norman White, Scranton, Pa.

Prevention of Silicosis Through Engineering Control: Warren A. Cook, State Department of Health, Connecticut, Chairman. James R. Allen, International Harvester Company; J. J. Bloomfield, United States Public Health Service; Thomas Donnelly, State Federation of Labor, Ohio; Prof. Philip Drinker, Harvard School of Public Health; C. H. Fry, Chief, Bureau of Industrial Accident Prevention, Department of Industrial Relations, California; Dr. Leonard Greenburg, Division of Industrial Hygiene, New York State Department of Labor; Dan Harrington, United States Bureau of Mines; Willis G. Hazard, Owens-Illinois Glass Company; E. O. Jones, American Foundrymen's Association; E. G. Meiter, Employees' Mutual Liability Company; W. P. Yant, Supervising Engineer, United States Bureau of Mines Experiment Station.

Economic, Legal and Insurance Phases of the Silicosis Problem: V. P. Ahearn, National Sand and Gravel Association, Chairman. Daniel D. Carmell, Assistant Attorney - General, Illinois; J. Dewey Dorsett, Industrial Commission, North Carolina; Evan I. Evans, Supervisor, Actuarial Division, Ohio Industrial Commission; John P. Frey, American Federation of Labor; Dr. Henry D. Kessler, Chairman, Rehabilitation Commission, New Jersey; Louis B. Raycroft, Pennsylvania Self-Insurers; Henry D. Sayer, Association of Casualty and Surety Executives; T. C. Waters, Chairman, Maryland Occupational Disease Commission; Robert J. Watt, Massachusetts Federation of Labor; S. E. Whiting, Liberty Mutual Insurance Company; and W. H. Winans, Union Carbide and Carbon Corporation.

Regulatory and Administrative Phases of the Silicosis Problem: L. Metcalfe Walling, Labor Commissioner, Rhode Island, Chairman. Dr. P. G. Agnew, American Standards Association; Dan Boney, Insurance Commissioner, North Carolina; Manfred Bowditch, Director, Bureau of Occupational Hygiene, Massachusetts; A. L. Fletcher, Labor Commissioner, North Carolina; Joseph A. Haller, Safety Engineer, Compensation Commission, Maryland; Ambrose B. Kelly, American Mutual Alliance; Oliver E. Mount, American Steel Foundries, Chicago; Michael J. Murphy, Director, Workmen's Compensation, New York; Victor A. Olander, Illinois Federation of Labor; Dr. Stanley Osborn, Health Commissioner, Connecticut; Dr. W. C. Woodward, American Medical Association; Voyta Wrabetz, Industrial Commission, Wisconsin.

Mine Cave-in in Nova Scotia Gets the Spotlight

CAVING OF GROUND around the incline shaft that constituted the only opening on a small property of the Moose River Gold Mines, in Nova Scotia, while the two partners in the mining enterprise, together with the timekeeper, were making a visit underground on April 12, wrecked the shaft and trapped the three men, and furnished newspapers far and wide with sensational stories, until finally two of the three were rescued after being entombed for twelve days. One of the partners had died of pneumonia before the rescuers arrived.

At the time the cave-in occurred the three men were alone on the 141-ft. level of the mine. Rescue parties were organized on top, the efforts of local miners being supplemented by those of others, including some equipped with Draeger breathing apparatus, who were sent from other points in Nova Scotia and elsewhere in eastern Canada, the work being conducted under the supervision of the deputy mines inspector. To reach the entrapped men, miners were sent down a near-by vertical shaft, from the 80-ft. level of which they finally gained access to the stoped and caved ground lying above the 141-ft. level of the incline. Pursuing a tortuous course to avoid large slabs and catching up the ground temporarily as they went ahead, these men finally came under the skip-road of the incline, and, following it downward, eventually reached the survivors, and released them. This rescue work, rushed as it was, was attended with great risk to the rescuers, the real heroes of the incident. In the meantime, a diamond-drill hole had been put down to the vicinity of the men; also the sinking of a vertical shaft over this area had been started and carried to a depth where blasting had to be stopped because of the risk it entailed for the other rescuers working below the men engaged in sinking.

Resultant publicity, in which radio broadcasting from the scene played an exciting part, magnified the occurrence out of its true proportions. When life is at stake, no such happening can fail to command attention, and the newspapers made the most possible out of the affair. Much remains to be learned about the conditions that permitted the accident to happen. It was stated recently in the Provincial Legislature at Halifax that the mine was under water as late as last January.

NEWS FROM WASHINGTON

By Special Correspondent

NO ONE can know, even with final enactment, the real meaning of the tax bill now in the making in Congress. Rebuilding of so fundamental a part of the Federal system as that which governs corporation payments to Uncle Sam has not proved a pleasant task for Congress, especially in an election year. But the House of Representatives accepted the most fundamental and far-reaching of the President's recommendations, and dutifully proceeded to draft a law which would base the tax not primarily on earnings but rather on the share of earnings which is withheld from immediate distribution as dividends.

Late in April it appears that the Senate will retain some of this principle. A major doubt as to the type of law which remains relates to excise (special commodity) taxes. Congress is proving much more reluctant to follow the President's suggestion in this regard; and uncertainty is growing as to whether the final bill will impose new levies of this sort.

Perhaps business men generally would have favored more taxes if they had been sure that the new law, when enacted, would really be a step toward a balanced budget. Any such step would, of course, help to spotlight the current extravagances. It would be welcome to business as curtailing expenditures, even though painful in imposing new money burdens. At least this is the way it looks in Washington. And this accounts for the fact that there is much less "conservative" opposition to the new tax bill than had been expected. But the high hurdles of the Senate remain to be jumped.

Tax Law Leaks

Career advisers of Congress and in the Treasury Department are worried about several features of the new tax law. They say that drafting such a radical revision is almost certain to leave unanticipated loopholes through which large taxpayers may safely escape. Furthermore, numerous exemptions, necessary to make a tax on undistributed earnings practicable, have been recognized from the beginning of the legislative effort; but no one knows just how far such exemptions will go in legalizing corporate escape from burdens. The estimates of prospective return from the new tax are, therefore, correspondingly uncertain.

And another worry seems very real. This is the difficulty of getting complete tax payment from individuals who receive dividends. It is not primarily a problem of evasion by those who legally should pay. It is far more a problem of exemptions and deductions on incomes of small size, often including significant totals of dividend money.

It will be strange if the estimates made by really competent persons, even after the final enactment of the new tax bill in early June, do not still show guesses ranging from $500,000,000 to $800,000,000 as prospective new Treasury income. Some are even guessing that the House bill as reported by a diligent committee would raise less than half of the expected $800,000,000, if it were not further perfected by the certain critical review of the Senate.

Potash Progress

Last year a trifle over 50 per cent of the United States supply of potash was from domestic production. This is, by a wide margin, a record for United States producers. Results thus far in 1936 indicate that domestic producers and importers are just about splitting equally the current orders. But these orders are totaling less than a year ago, when speculation against price rises occasioned the building up of stocks in the hands of the principal producers, the fertilizer makers.

Regarding prices the American Potash Institute recently said: "A statistical study of potash prices over the past few years shows that the price level of potash salts dropped much below that of general prices. During the recent period of rising prices, potash prices still held at a much lower level than that of other materials the farmer buys or sells. Potash is now relatively one of the cheapest products which a farmer buys, a situation strongly favoring recommendations for adequate usage to insure profitable yields of quality crops.

"In 1929 and 1930 prices in general began a steady decline, which reached the depression low in March and April, 1933, and then began the gradual rise which brought them in March, 1936, to 79.6 per cent of the 1926-28 average. The level of prices of commodities purchased by farmers followed the same course, reaching its low point in 1933 and advancing to 78.3 per cent of the 1926-28 average in March of this year.

"Potash prices in March, 1935, reached their lowest point in history and in March of this year stood at 64.2 per cent of the 1926-28 average, approximately half the price levels of January, 1931."

Mineral Monopolies

Both potash and fertilizers have been under fire in Washington lately, price fixing and restraint of trade being charged. Neither charge has, however, been taken very seriously as it relates to these particular commodities. But all of the mining industry will be concerned regarding an important byproduct development in the plans of the Department of Justice.

Justice Department officials would like a special unit of trained anti-trust investigators. Clear definition of this desire is an important byproduct of a Congressional request as to what has been done to break up "price fixing" in fertilizer. No real fertilizer investigation is expected, but plenty of others would follow if Assistant Attorney General Dickinson's desires for a new appropriation were approved.

Representative M. C. Tarver, of Georgia, really started the revelation of anti-trust sleuthing plans when the Assistant Attorney General was appealing to the appropriations subcommittee for small increases in funds for the Justice Department. The request was for a special economic investigation section for the anti-trust division. That proposed unit, to be headed by three chief investigators with aggregate salary of $20,000, has been asked because Justice officials often wish they could go ahead on their own studies without waiting for Federal Trade Commission inquiries to be completed. Thus the old

Standing Pat

CONTINUATION of the same fundamental policies in his second four years as President was virtually promised in the Baltimore address by Roosevelt last month. Rigid regulation of business by Government—wages, hours of employment, working conditions—and aggressive efforts to discipline management which does not conform to reform ideas, are all the unaltered purpose clearly displayed on this occasion.

The address, generally regarded as the opening statement of the campaign for continuance of the New Deal another four years, included nothing more significant than the following words:

"Do something. If it works, do it some more; and if it does not work, do something else."

Thus there is pledged an experimental policy in matters social, economic, and industrial.

jealousy between the department and the commission continues to be a factor. Also, Dickinson complains that the Department of Justice cannot get enough help for anti-trust studies, even by loan from the Bureau of Investigations. Its G-Men are too busy.

Informed Washington had a good laugh over Tarver's request that price maintenance by the fertilizer industry be investigated. Actually the industry is this year up to its old price-cutting.

Recent effort to stimulate phosphate-rock production in South Carolina apparently has official encouragement in that State because of the anticipated return to the State Treasury of 50c. per ton. The fact that a corporation recently was authorized to mine not exceeding 5,000,000 tons of rock per year inevitably has occasioned comparison of this talked-about capacity with United States Geological Survey estimates that the total phosphate reserves of South Carolina are about 9,000,000 tons, principally low-grade rock.

WPA vs. PWA

The old Hopkins-Ickes controversy rages on in Washington. It is not only a conflict of two vigorous personalities. It is also a clash of fundamental principles. Boondoggling vs. public works is the real issue.

Quite to the amazement of many Washington observers, some in Congress, during April, swung strongly away from the Hopkins ideas and gave support to Ickes, hitherto the Congressmen's "pet hate" of the Cabinet. The explanation is of great importance to suppliers of minerals and metals employed in the construction industries. It represents a potential influence in favor of construction of the modern durable type and against the dissipation of Federal emergency moneys on activity of less permanent nature. If this trend continued, it seems certain that the President would not be given the unrestricted allotment of $1,500,000,000 which he requested.

Should the President choose to put pressure on for an appropriation unrestricted and without earmarking, he can undoubtedly get such fund almost unencumbered by Congressional rules. But the President does not like further to antagonize many. And Washington believes he is not likely to fight this trend if it should prove as important as some wishfully forecast. Industrial executives seeking to influence the matter are pressing their spokesmen, and impressing their Congressional friends, with the thought that durable construction should be more desirable at this stage than the leaf-raking relief efforts, even though the latter seem less costly per man.

At the moment an incidental, but fundamentally most important, aspect of this matter is the conviction of Washington that all these relief efforts will make no further progress on reducing the total number of unemployed. Even the most ardent spokesmen for relief hesitate to claim that further reemployment will go on except as business activity increases.

Mine-Tax Inquiry

A comprehensive study of present tax burdens as they influence the economic development of mining has been proposed in Washington. This proposed investigation is ranked by its proponents as second only in importance to the study of deficiency minerals as a factor in the national economy. It is being strongly urged on the National Resources Committee as one of the major undertakings for the next fiscal year.

If such study is undertaken the effort will be first to make a compilation of the present tax burden—municipal, country, state, special, and Federal. Then the effort will be to correlate these tax burdens with the alleged benefits to the industry and to see whether the industry is at all times "paying enough as a separation tax for the depletion of national resources which it occasions." In late April no decision had been reached as to whether or not this project would be initiated on July 1.

Scrap Survey

DEFINITE PROGRESS has already been made on the secondary metal study to be made by the Government. The Bureau of Mines was not given sufficient funds to cover all metals and decided to limit its first undertaking to iron and steel scrap. For this work a staff of field investigators has been selected under the methods of WPA, and is being paid by that agency. In advisory direction of the work, Benjamin Schwartz, director general, Institute of Scrap Iron and Steel, Inc., has been named. The Bureau, in commenting on this situation, has been most complimentary to the industry and to Mr. Schwartz's assistance. This has aided the Bureau in arranging that this project be lifted out of the class of boondoggling and made a survey of real value to the industry. "The cooperation of Mr. Schwartz and his organization, guarantee a valuable result from this study," according to J. W. Furness, chief of the economics branch of the Bureau.

Tin Export Rules

Early in April, Secretary of State Hull announced the regulations fixed by him as agent of the National Munitions Control Board, intended to protect domestic supplies of tin. There were also prescribed the necessary forms on which application for exports might be made, but it was announced that no export licenses for tin plate scrap would be issued between April 16 and July 1. After July 1, new consideration will be given as to whether applicants for export will be granted permits.

For the purpose of administering the law, Secretary Hull rules that "the term tin-plate scrap is construed, provisionally, to mean tin-plate clippings, cuttings, stampings, trimmings, skeleton sheets, and all other miscellaneous pieces of discarded tin plate, which result from (1) the manufacture of tin plate, or (2) the manufacture of tin-bearing articles from tin plate. As thus defined, the term tin-plate scrap does not include tin-plate waste, tin-plate circles, tin-plate strips, tin-plate cobbles, and tin-plate scroll shear butts, when packed separately and sold as such, and when not intermingled with tin-plate scrap."

New Depletion

Some of the mining industry is now skimming only the cream of its reserves. This conclusion has been reached by official Washington observers of the industry. It is based essentially on the trend of production data being reported by the mining industry itself. For example:

The copper industry appears at the present time to be processing copper ores averaging over 50 per cent more in copper content than the 1.4 to 1.5 per cent average of other recent years. Also, it appears that the production of copper per man-hour was roughly twice as great last year as in previous years. These results are connected as cause and effect by Washington observers. They do not believe that mechanization has had as much to do with increasing productivity per man as has the mining of selected high-concentration orebodies.

A more likely explanation from the industry's viewpoint is that, during the depression, with reduced metal consumption and low prices, it has been necessary to mine higher-grade ore in order to continue operations, leaving lower-grade ore for more favorable economic conditions.

Mine Mechanization

Those interested in continuous progress of industry have found some comfort in the President's explanation of the fact that fewer human beings are engaged today in turning out production equal to the pre-depression peak. The President in this connection says, "It may be a greater efficiency; it may be the development of new machinery; it may be a variety of other causes. We cannot legislate against greater efficiency, nor can we legislate against the use of new tools—nor would we if we could. But the fact remains. And that fact requires an answer."

New Projects in California

Montezuma-Apex Gets the Union, Empire-Star the Jefferson and E. A. Stent the Gover-Fremont—Some Mills to Be Enlarged

EXTENSIVE DEVELOPMENT will be started at the Sneath and Clay mine, southeast of Nevada City, Calif., as soon as the 400-ft. shaft has been unwatered. The property was reopened recently by C. C. Van Loben Sells. Rehabilitation is directed by Byron Eastman.

✦ Montezuma-Apex has acquired the Union mine, near El Dorado, from Goldfields Development Company. Arrangements are being made to increase its underground crew for development on a larger scale. J. A. Norden is general manager.

✦ New flumes are under construction and equipment is being reconditioned preparatory to resuming production at the Relief Hill placers, near Nevada City, operated by Relief Hill Mining Company.

✦ The Jefferson mine, in Browns Valley, Nevada County, is reported purchased by Empire-Star Mines, owners of the neighboring Pennsylvania mine and other holdings. Operations are confined to development. Ore taken out in the course of this is trucked to the North Star mill, at Grass Valley. G. A. Kervin is in charge.

✦ E. A. Stent is said to have acquired the Gover-Fremont property, near Drytown, Amador County. The mines cover a 4,200-ft. stretch of the Mother Lode, and are opened by two incline shafts to a depth of 2,500 ft. vertically. A 40-stamp mill is available.

✦ A heavier hoist powered by a 100-hp. motor is being installed at the Erin-Go-Braugh mine, near Jamestown, operated by the California Standard Gold Mines Corporation.

✦ Columbus Gold, operating near Tuolumne, plans to increase the capacity of its ten-stamp mill to 100 tons by installing a ball mill. J. B. Sivori is superintendent.

✦ Open-pit mining has been resumed at the Calaveras section of the Carson Hill property, at Melones, operated by Carson Hill Gold, after a brief interruption. Hamilton, Beauchamp & Woodworth are to draw up plans to increase the mill capacity from 1,000 to 1,200 tons.

✦ The Three Star mine is being unwatered by International Mines, A. N. Massey, superintendent. It is in the Ophir district, near Auburn.

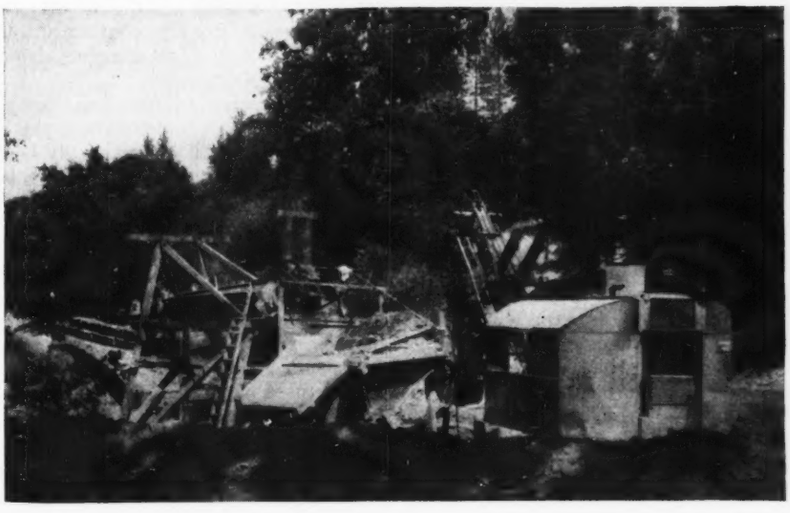
✦ Idaho-Maryland plans to install a new 360-ton cyanide plant for treating tailing sands at its Idaho property.

✦ Pioneer Dredging, W. A. Hilliard, manager, at Redding, has purchased 3,500 acres of placer ground on Dry Creek from Mrs. Patsy Marcher, of Oroville, and plans to install a second dragline.

✦ Republic Gold's Empress mine, near Grass Valley, has been shut down because of damage to the main shaft by swelling ground. The owners have started a detailed survey under the direction of R. C. Eisenhauer, with a view to sinking a new shaft. Attachment for $13,700 on tangible property has been served by Alpha Stores, Nevada City.

✦ Unwatering of the Oro Fino mine, near Auburn, has been completed and sampling of underground workings started. The property is operated by Oro Fino Consolidated Mines.

PLACER OPERATION alongside of the Mother Lode Highway three miles north of Plymouth, Calif. The equipment consists of a ¾-yd. gasoline shovel and a portable washing plant mounted on skids. Output is from 200 to 250 cu.yd. of gravel per day. Elwood Orr is in charge of operations



Options Multiply in Nevada

Outside Interests Have Various Properties Under Consideration—New Ore in Dan Tucker and Chiquita Mines

THE option on Consolidated Virginia, on the Comstock, secured by John J. Raskob and associates, which was to terminate April 1, has been extended to July 1.

✦ Mountain Copper has taken an option on the old Commonwealth silver-lead-zinc mine, in southern Washoe County, Nev., from C. N. Miller, of San Francisco. The ore is complex and has been tested for flotation.

✦ Eastern Exploration, subsidiary of Calumet & Hecla Consolidated, has been doing geologic and development work on property of the Goldfield Consolidated, which is under lease and option. Part of this area has been subleased to Goldfield Deep.

✦ International Smelting has taken an option on the Gordon-Brodie gold mine, in the Silver Peak district, Esmeralda County. The Gordon Mines Company has developed some free-milling gold ore and for several months has been running a 30-ton amalgamating mill.

✦ United Goldfields Company from the bottom level of its No. 1 shaft has developed an oreshoot for a length of 300 ft. in the Dan Tucker mine, at Sand Springs, in Churchill County. A 300-ton mill is to be moved to the property.

✦ Deposits of dumortierite are yielding substantial shipments near Limerick Canyon, Pershing County. They are owned and worked by the Champion Spark Plug Company. Arthur Cole is superintendent.

✦ Sulphide gold-silver ore opened on the tenth level of the Chiquita mine, near Goodsprings, Clark County, is being mined for shipment. Oxidized ore of mill grade has been developed to 1,000 ft. Equipment for a 50-ton mill has been delivered.

✦ The East Standard Mining Company, developing property at Midas, Nev., has advanced its lower tunnel 1,350 ft. from the portal. A blind vein, 2½ to 4 ft. wide, carrying good values in gold, was struck. Development of this showing is being carried on. A flow of water, running about 60 g.p.m. will help greatly to expedite operation of the mill.

Idaho Men Organize Nancy Lee

A New Silver Project Across the State Line From the Coeur d'Alenes—Development Planned for Sunshine Consolidated

THAT another silver belt, like that of the Sunshine and dry-ore belt region, has been discovered across the Montana line from the Coeur d'Alenes, is held by some engineers and geologists. The heart of the district lies a short distance northwest of Superior, at Keystone. Mining men of Kellogg and Wallace have moved to consolidate the several groups into a compact unit. Nancy Lee Mines, Inc., has been formed under Idaho charter, and titles have been conveyed, covering the former King and Queen group, Keystone claims, Eldorado group, O.R.&N. holdings, and the Peter the Great property. The new corporation owns outright ground a mile long along the vein systems and 4,000 ft. wide. Work is under way to open the King and Queen at depth. A deep tunnel now in 300 ft. will reach the ore at 1,200 ft., several hundred feet below the upper levels where silver ore was disclosed. Alexander Leggat, of Butte, is consulting engineer.

✦ Polaris mine is to be equipped with a mill as soon as sufficient ore is blocked out, according to James F. McCarthy, president of the Hecla and Polaris companies. A drift 438 ft. long on the 920-ft. level has been reported as being in commercial ore for the entire distance. Plans are also being considered for a mill to treat ore from the Star mine, now being concentrated at the leased Hercules mill. The Star is owned by the Sullivan Mining Company, of which the Hecla and the Bunker Hill & Sullivan companies are joint owners.

✦ The Clayton Silver mill, in Custer County (under control of Coeur d'Alenes operators), is to be enlarged from 100 to 300 tons' daily capacity, according to H. B. Kingsbury, president. The plant now lacks secondary grinding facilities. A 300-hp. hydro-electric plant is also planned. Mine development has been retarded because of lack of ore storage facilities.

✦ Plans for comprehensive development of the Sunshine Consolidated, Inc., on the Coeur d'Alene silver belt, were discussed at the recent annual meeting held in Kellogg. Frank Eichelberger, manager of the Sunshine and consulting engineer for the Consolidated, reported that contracts entered into between the two companies were favorable for both. Drifts on the 1,700, 1,900 and 2,100 levels of the Sunshine are being extended westward toward Consolidated ground, with the ore raking in that direction. Completion of the new four-compartment Sunshine shaft to the 1,700 level will facilitate operations of both companies.

✦ Work at the Palisades property, at the head of the west fork of Pine Creek, is getting under way, according to Theo. W. Schmidt, manager. Snow is still a handicap and lack of a road up the creek makes packing difficult. A drift has been started on the quartz-siderite.

✦ The Giant Ledge group, 4 miles above Murray, has been taken under lease and bond by E. F. Rose, of Portland, who plans to start work immediately. The property is owned by J. O. Storey, of Portland. It was formerly known as the Granite & Allie.

✦ The 680-ft. raise from the 1,000 level of the Mineral Point property of Coeur d'Alene Mines Corporation lacks approximately 95 ft. of its objective, which is the 450 level, and all work is being centered on its completion. Progress is being made at the rate of 7½ ft. per day, and it is hoped to hole through by the first of May. Above the 450 level, two orebodies await developments. In addition to the vein opened by crosscuts from the 700 and 575 levels, and which will continue above 450, an orebody 20 ft. wide was opened on the 100 level in the hanging wall of the shearing, being 350 ft. above the 450 level. This orebody will be further prospected after production is started, and is expected to add considerable tonnage to the output. President Nuzum has announced the payment of $50,000 on the bond due the former owners, which is one-half the amount owed. An extension of time on the remaining $50,000 was granted to Oct. 15, officials stated.

✦ Howard Stapleton, manager of the Pontiac property in the Murray belt, reports that the snow is disappearing rapidly at the mine and he hopes soon to have the roads opened to the property, so that supplies and equipment may be taken in and work started in the deep tunnel. An aggressive development campaign has been mapped out by Mr. Stapleton for this season, and he expects to have the property under production before another winter sets in.

BELIEVE IT OR NOT, a snow slide along the trail to Camp Bird Mine, Ouray, Colo., hoisted a tree to this fantastic position

Courtesy Chas. N. Bell, King Lease

Mine Employment High in Colorado

CURRENT mining activity in Colorado is indicated by the employment of 13,000 to 14,000 men at nearly 600 operating metal mines and mills. Nearly half the mines and employment is in the Front Range district, comprising Boulder, Gilpin, and Clear Creek counties. About 4,000 men are engaged in the Cripple Creek district, and 3,000 in Leadville, including Climax. In the San Juan about 1,200 men are at work.

✦ American Smelting & Refining Company has purchased the Alice property, in the Idaho Springs district, and has put 30 to 40 men to work.

✦ Cripple Creek is producing what is the largest tonnage in 25 years. Daily shipments out of the district are about 2,000 tons. In addition, the Cripple Creek Milling Company is treating 400 to 500 tons per day in its new cyanidation-flotation mill.

✦ A. O. Smith Corporation is operating its 100-ton mill at Summitville to full capacity.

From Gunpowder To Modern Dynamite

(Continued from p. 234)

one row back of the other and both parallel with the free face, the holes of the first row will have relieved those of the second before the charges of the latter go off, so that all holes may be equally effective. Breaks in the continuity of a charge cannot prevent complete detonation of the isolated parts.

The discussion of fuse has thus led directly into that of detonators, the development of which had naturally begun years before. Blasting caps came into use soon after the invention of dynamite. In 1869 T. P. Shaffner patented a blasting cap containing fulminate of mercury for use with safety fuse. This fulminate was the detonating compound most generally used until lately. It has now been partly replaced by other compounds, of which tetryl is one. Tetryl is always used with a priming compound. Until the latter is added, it is much safer for the manufacturer to handle. Caps, briefly, consist of cylindrical shells of cop-

(Continued on p. 259)

Arizona Mining Improves

International Smelter Resumes Work —Molybdenum Gold Mill to Be Enlarged—Progress in Placer Operations Reported

MOLYBDENUM GOLD'S MILL, at Mammoth, Ariz., which treats the ores from the Mammoth, Mohawk, and New Year mines, is to be enlarged from 200 to 300 tons' daily capacity. The flotation concentrate, containing gold, silver, lead, zinc, molybdenum, and vanadium, is shipped to the plant of Molybdenum Corporation of America at Washington, Pa. Foster S. Naething, managing director of Mammoth-St. Anthony, is also manager of the Molybdenum mill.

✦ The International smelter at Inspiration has resumed operations. It is employing 150 men to handle accumulated Miami Copper concentrates.

✦ Bagdad Copper, at Hillside, is planning additions to flotation and filtering equipment to provide full capacity on the higher-grade ore. The mill was designed to treat 1.25 per cent copper ore, whereas the present feed runs 5 per cent. George G. Thomas is general manager.

✦ Development work is in progress at the Carper claims at Tombstone. A small hoist has been installed and some ore is being mined from the 75-ft. level. The property is leased by J. H. and Herbert Macia and C. C. Robertson.

✦ The Old Hat mine, near Oracle, is being opened by Davenport and Herron, of Mission, Tex. The sulphide zone was reached at 75 ft.; sinking is to continue to 150 ft. before drifting. H. J. Herron is in charge.

✦ The Patsy placer group is being worked by Frank J. Gillick, of Octave. The placers consist of high bars on Weaver Creek, having about 20 ft. of gravel over bedrock, with about 2 ft. of overburden.

✦ King Tut Placers are handling about 600 cu.yd. of gravel per 18-hour day. Production is to be doubled upon completion of water-reclamation settling ponds. The company has launched a 38-ft. motor boat on Lake Mead to transport supplies from the Union Pacific at Boulder City.

✦ Silver Flag has enough ore developed to warrant consideration of a pilot plant. John Carroll, of Wickenburg, is superintendent.

✦ Regular shipments of ore are being made to the Clarksdale smelter by the Bullard gold mine, 8 miles north of Aguila. The property is operated under lease by George W. Long, of Phoenix, and W. O. Meier, of Scottsdale.

✦ The Seventy-Nine Lead-Copper Company, Hayden Junction, has contracted with Southwestern Engineering for a gravity and flotation plant. The company has been shipping about 1,000 tons of ore monthly to the El Paso smelter since the mine was reopened in July, 1935. D. C. Peacock is in charge.

✦ Monte Christo Gold Silver has resumed operations after a six months' shutdown. The mine has been dewatered below the 800, where a new drift will be necessary because of caving. Current production is coming from the 400 level. George Taylor is superintendent.

DRILLING with standard drifter suspended from steel tripod on bench at pit of New Cornelia Branch of Phelps Dodge Corporation, Ajo, Ariz.

✦ Papago mine, in the Growler district, is to have a mill at the Copper Hill property, where water rights have been obtained by the lessees, G. A. Carmien and M. Flower.

✦ Amulet Operating Company has acquired the Blue John group at Walker, and renamed it the Blue Diamond. The shaft is being dewatered and retimbered to reach a block of milling ore. Work is progressing on the Amulet No. 4 and Fidelious shafts under O. O. Smith, general superintendent, of Prescott.

✦ Empire Mining & Refining Company, with headquarters in Albuquerque, has purchased the Pendergast and Brutis claims in the Weaver Creek district of Yavapai County. A 30-ton pilot mill is planned.

✦ Veta Mines Corporation, at Duncan, has started development work on the Ash Peak mine. Plans for installation of power plant and mill are being made by Douglas McHendrie, vice-president, of Denver. Henry P. Nagel, Jr., is superintendent at the property, which is a low-grade silver mine.

✦ Liberty Hill Gold is cutting a station at the 200 level in its development campaign under the management of L. L. Farnham.

(*Continued from p. 258*)

per or aluminum having a charge of detonating material within. This is exploded either by safety fuse inserted in the cap or electrically. Electric blasting caps have a bridge wire of platinum or base metal passing through the charge.

In 1888, battery blasting caps first came into use. But although the invention of electric firing for explosives antedated that of blasting caps (the first patent having been granted to Moses Shaw in 1830), electric blasting caps were not generally introduced in the United States until early in the present century. The advance in the last 25 years has lessened the dangers of blasting considerably. As electrical energy became more applicable to mines, the hazard increased somewhat. A simple shunt device which is removed just before the wires are connected to the blasting machine now prevents premature explosions in mines where there are many electrical units.

By placing a timing element or fuse within the cap the so-called delay electric blasting cap is produced. This element is usually of a black-powder composition. In addition is the delay electric igniter, which becomes a detonator with the addition of a blasting cap.

Explosive manufacture has scored most of its advance since 1860. The characteristics and properties of explosives today are many, and they serve many phases of industry besides mining. Experienced explosive engineers have determined the efficiencies of the various strengths of explosives and to what purpose they are best suited, be it mining, quarrying, construction, or their application to geophysical prospecting. The field is very broad, and it is interesting to note that 370,000,000 lb. of dynamite and black powder were transported on the railroads of the United States and Canada in 1935, with a safety record of no one killed or injured, and with no damage to property. Though the safety factor has increased considerably, all manufacturers insist upon great care in all phases of manufacture in their plants, and teach the same observance of safe practices on the part of the consumer.

Early Spring Spurs Utah Mines

United States Smelting to Start Crosscutting Into Burns Ground at Park City—Ophir Hill Camp Active—Frisco District Shipping Steadily

AN ADVANCED SPRING has stimulated activity at Utah producing mines and prospects. Various companies are preparing to resume work after the winter's layoff.

✦ In the East Park City district, the United States Smelting, Refining & Mining Company is planning to start driving a crosscut from the Star of Utah tunnel of the New Park Mining Company into its recently acquired Burns ground, 5,000 ft. away.

✦ New Park Mining Company recently purchased the Crescent and Sultan claims. The company is working three shifts in its Park Galena tunnel in property adjoining the Star of Utah adit to reach the Park Galena fissure in the sedimentaries. The lower or Mayflower tunnel of the company is now 5,280 ft. from the portal. The company has organized the Gold Queen Mines Corporation to develop the Superior group of 110 acres, south of the Flagstaff properties.

✦ A shaft is to be sunk by the Park Standard to develop the gold ore cut in the tunnel in the Park City formation, where a mineralized limestone carrying low-grade values has been exposed.

✦ Ophir Hill is active. The Hidden Treasure is shipping ore by truck. The Lakes of Killarney will resume. Ophir Midland is under development. Tintic Ophir Mines Company recently acquired 400 acres of mining property on Lion Hill by taking over the Ophir Metals groups, thus putting the control of 1,200 acres in this richly mineralized area under one management.

✦ Utah Central, in the Detroit district, Millard County, shipped six cars of ore during March to Salt Lake valley smelters. A. B. Muelstein, on the E. P. H. claim, produced two cars; R. Twitchel and associates, three cars, from the Ibex; Joe Willard and associates, one car, from the Hard Times.

✦ Steady shipments of a high-grade silver-lead ore continue from the Frisco Silver Lead Mines Company, adjoining the King David property, in the Frisco district near Milford. This development is thought the most important made in recent years in this area, famous for the old Horn Silver mine. On the 250 level a considerable body of lead ore, carrying sulphides and carbonates, has been developed and shipments are being made. The ore is associated with the Jumbo fissure, in the east-west major fissure system.

✦ The King David mine, controlled by the Tintic Lead Mining Company, which owns the Horn Silver, has a promising showing on the 750 level, where the company is drifting north to cut the Horn Silver ore zone. North-south breaks show increasing mineralization, with good values in silver, lead, and gold.

✦ The North Lily Mining Company reported a net loss of $12,780.05, without deduction for depletion, in its annual stockholders' report for 1935, just released. No company work was done, but leasers produced 2,605 tons of ore, dry weight. The company, by an issuance of treasury stock, acquired mining claims and mines valued at $101,500.

✦ The Lewiston Peak Mining Company, operating at Mercur, is working in an extensive area. Sixty men are employed. The incline shaft in the Golden Gate property has been sunk to the 700 level, where drifting is under way.

✦ Leasers are shipping from the 45-ft. level of the Chloride shaft in the Galena property, in the Beaver Lake district. Samples of a recent shipment ran 48.8 per cent lead and 55 oz. of silver to the ton. A tramway has been built, a portable compressor installed, and the Chloride shaft retimbered to the bottom at a depth of 90 ft.

Lake Ore Shipping Held Up

Iron Mining Operators Anxious to Start—Sibley, on the Vermilion, Changes From Steam to Electricity—Scrap Piles Dwindle

COLD WEATHER has been holding back the opening of navigation, and old forecasters now predict the first boat will get down the Lakes about May 15. With so many rush orders on hand, the mining operators, having their equipment in condition for a full season's work, are anxious to go.

✦ This month marks another major change for Minnesota mining in that the last large producer using steam for power has now changed over to complete electric operation. This was the Sibley mine of the Oliver company at Ely, on the Vermilion range, an underground mine.

✦ Because of the fine safety record of all mines of the Pickands-Mather Company in Minnesota the Joseph A. Holmes Safety Association awarded the company a safety certificate of honor as a group and included eight mines. Other mines in the State receiving such honors were the Mesabi Chief and Mississippi of the M. A. Hanna Company.

✦ High prices for scrap iron have been an incentive to various operators not only to clean up their scrap piles but also to cut up old equipment that has outlived its usefulness. The Oliver has been cutting up old steam shovels, the smaller class of locomotives, and, in the Virginia district, several 30-cu.yd. center-hinge dump cars. This gives the side tracks a spick-and-span appearance not seen in years, and obviates also paying taxes on obsolete machinery.

Long Life for Copper Range

New Developments in Globe Ground Promise Well for Future—Calumet & Hecla's Ventures in Gold Mining Are Encouraging

WITH the opening by Copper Range of its new lode, or the extension of the Baltic vein, in Globe lands, which are under option until July, 1939, a tubular steel-reinforced concrete drop shaft is being sunk over the Old Globe timber shaft, which was sunk 1,000 ft. in 1905 and 1906 and abandoned in 1909. The lode has been opened at greater depth by means of a drift from the 18th level of the Champion mine. This has been driven across the Globe property, disclosing a mineralized vein, 3,700 ft. in length, of fairly uniform strike. Also, 300 ft. of good ground was disclosed by drilling further south. Yield from Champion rock last year was 57.56 lb. of copper per ton of rock treated. This is exceptionally high for an amygdaloid mine. It is obtained through close selection, the most profitable method of mining in the Michigan district.

✦ At the north end of the lode in the Globe property, 300 ft. of drifting showed commercial ore the whole distance. Between the areas drifted on a section 1,900 ft. long has been drilled, showing copper, but has not yet been checked by drifting. The vein is richer in silver than the lode in the Champion mine, shipments averaging 74 oz. per ton of ingot copper, or three or four times as much as the Champion average. The new shaft will facilitate the development of the vein. It will be deepened to connect with the 18th level, which will serve as a new base of operations. Meanwhile, a new drift is being driven from the 9th level of Champion, which will intercept the shaft at about its present bottom.

✦ At Calumet & Hecla Consolidated's gold properties in the Ishpeming district

in Michigan and at Goldfield, Nev., prospects are considered good. Exploratory work to date is not discouraging and is the incentive for a thorough investigation of the lands held under option. In the Ishpeming field, work done indicates the possibility of large tonnages of low-grade material. Both drifting and diamond drilling are under way in the old Ropes mine shaft. At Goldfield, areas not heretofore explored, but considered promising, are being investigated.

Tri-State Mines Curtail

Concentrate Output Hits Five-Year High—Operations Resumed by Federal at Muncie Property—Unwatering of North Webb City Field Progresses

CURTAILMENT has been revived in the Oklahoma-Kansas-Missouri district. Production of zinc concentrates reached 10,800 tons early in April, the highest figure in five years, and immediately smelters began to reduce purchases until some producers were finding it impossible to sell their output. Many companies have decided to cut weekly output 20 per cent for three months or until demand picks up.

✦ Federal Mining & Smelting has resumed work at the Muncie mine, at Treece, which has been idle for six years.

✦ A new 14-in. Pomona pump has been installed at the Robinson shaft, in the North Webb City district, by the Eagle-Picher Company. In this section Eagle-Picher is operating three pumps, which are lifting about 13,000 g.p.m., dewatering the old Missouri fields for several miles.

✦ Dewatering of the Webb City and Carterville district is expected to bring about additional operations before summer arrives.

Activity in Canada Marked

Red Lake Area, in Ontario, More Promising—Dome's Sigma Mine, in Quebec, Now Has 118,000 Tons Reserves—British Columbia Busy

THE Red Lake area of northwestern Ontario is expanding rapidly in importance, in spite of the dwindling hopes of the Howey mine, its principal producer. The Howey operation has been of prime importance in Canadian gold mining, having demonstrated two points: first that a distance of a hundred miles or more from a railway is of small consequence under the natural conditions of northern Canada, and second that certain of the Canadian gold ores can be treated at a cost formerly considered impossible. Howey's operating profit in 1935 was $211,282, the recovery from 402,270 tons of ore milled being $1,319,764. The operating cost was $1.74 a ton, and for the first quarter of this year it was reduced to $1.56 a ton. Development on the 1,500 level has been disappointing, and new levels are to be opened this year down to 2,000 ft.

✦ MacKenzie Red Lake's new mill treated in nine months last year 36,117 tons of 0.43 oz. ore for a recovery of $533,205 and an operating profit of $225,531. The mine is now developed to 450 ft., and two more levels will be opened during the year. Red Lake Gold Shore, west of Howey, has now developed 45,500 tons of 0.66 oz. ore to 550 ft., with additional ore coming in as drifting is continued. A 125-ton mill is now being built, and another level is being established at 675 ft. The adjoining Madsen property should soon be ready for a mill. Half a dozen other properties on or near the shores of Red Lake are being developed underground. At Clearwater Lake, nearer the railway, the Argosy mine, already equipped with a mill, is responding to renewed development, and the mill is soon to be put in operation on ore of about $20 grade, of which there is now 50,000 tons in sight. Hudson-Patricia is installing a 50-ton mill after developing 35,000 tons of ore.

✦ At a similar distance from the railway, but with the advantage of higher-grade ore, Central Patricia and Pickle Crow have growing reserves and expanding mills. The three new levels of Pickle Crow, at 500, 625, and 750 ft. are yielding ounce ore in all drifting to date, for widths of about 3 ft., which are likely to become wider and of slightly lower grade with slashing, as on the upper levels. The mill is at about 175 tons at present. Central Patricia is treating 150 tons daily of $20 ore. Development of the bottom level at 500 ft. has been highly satisfactory.

✦ Young-Davidson, subsidiary of Hollinger in the Matachewan field, ran a close second to Howey for low-cost honors last year. The operating cost of $2.10 a ton included mining, 66c.; milling, 88c.; development, 27c.; overhead, 29c. Open-pit mining will be carried on only during the summer, as winter work in the open is inordinately expensive. The 600-ton mill will be doubled in capacity this year.

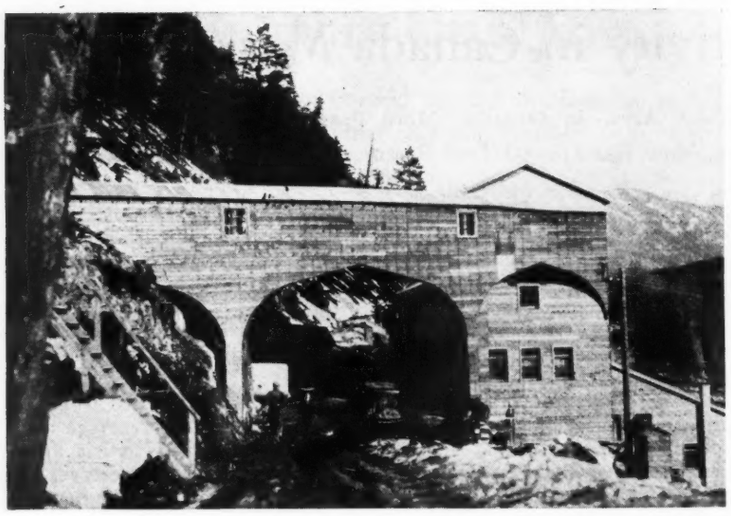
✦ The neighboring Matachewan Consolidated mines, operating on vein occurrences of the usual type, is treating 150 tons daily. Last year, the first of mill operation, the output was $356,823 from 48,362 tons milled, an average of $7.38, giving an operating profit of $78,827. The reserve at the end of the year was 126,000 tons of 0.228 oz. grade ($7.98). The bottom level at 260 ft. is yielding ore in volume and grade comparable to the first level.

✦ Falconbridge Nickel during 1935 treated 302,510 tons of ore for a recovery of 10,735,756 lb. of nickel and 5,029,525 lb. of copper, which brought an income of $4,640,373, of which $1,768,558 was net profit. Precious metals are now being separated from the electrolytic refinery sludge, but no income was derived from them last year.

CAL HORR MILL, in the Philippines, has been recently completed and production is on a basis of 150 tons of ore per day. This is one of the newest mills in the Philippines and is operated by Benguet Consolidated

QUEBEC

✦ Canadian Malartic is Quebec's present low-cost gold producer. February operating cost of $4.06 per ton includes development, $1.10; mining, $1.19; milling, $1.00; and general, 49c. As the orebodies are large and consistent, these costs, particularly development, will be reduced considerably. Recovery for February was $6.13 per ton, with the mill at 300 tons daily. The estimated



MILL OF MINTO GOLD MINES, LTD., in the Bridge River district of British Columbia. The covered trestle crossing the road leads into the Main tunnel, which is the haulage level. The River tunnel, where the high-grade ore mentioned in the accompanying text has been opened, is at a further depth of 80 ft. Its portal is beyond the river bank beyond the mill.

ore to 600 ft. is 600,000 tons of $7 grade.

✦ On the first level of the Sigma mine, adjoining Lamaque in the Harricana area, 700 ft. of ore across drift width averages about 5 dwt. after high erratics are cut. This is duplicated on the second level. The third and fourth levels, at 350 and 475 ft., are now being developed from a new shaft with steel headframe and equipment designed to hoist 500 tons daily from a depth of 2,000 ft., which the management considers adequate for any probable output. The ore disclosed so far is in three zones in a width of 350 ft. The deposits vary greatly in dip, and the disposition of gold in them is rather erratic, much of it being coarse as in the Lamaque. Dome has now spent two years and over $500,000 in developing Sigma and success seems assured. At the annual meeting of Dome it was announced that Sigma has now 118,000 tons of 5 dwt. ore in reserve. The mine will be developed to 1,000 ft. before the question of a mill is decided. Dome Mines is developing the property.

✦ Perron Gold's new mill is treating 140 tons a day, with a monthly output of $40,000. At the end of last year J. P. Norrie, manager, reported on the first level at 175 ft., 3,000 ft. of vein opened, averaging 0.42 oz. across 5 ft., and 1,000 ft. averaging 0.39 oz. across 4½ ft. on the second level, at 325 ft.

BRITISH COLUMBIA

✦ Mineral products to the value of $22,946,348 were sold by the Consolidated Mining & Smelting Company of Canada during 1935, according to the company's annual report, issued recently. Operating profit was $7,304,559. During the year work was continued on the new sulphur-reduction plant, and production of elemental sulphur therefrom will be commenced in June. Operations were carried on at a number of properties owned or held in different parts of Canada and Alaska. At the Big Missouri, in the Portland Canal district, sufficient ore has been proved to warrant the construction of a 500-ton mill, but as the existence of a considerably larger ore supply is indicated development will be continued to justify the construction of a larger plant.

✦ At the Premier mine, No. 5 level is being driven into B. C. Silver ground, the old B. C. Silver workings are being rehabilitated, and No. 6 level is being prepared for entry from the Premier workings. The work is being done by the Silbak Premier Mines, Ltd., which was formed last year to acquire and operate the adjoining properties of the Premier Gold Mining Company, Selukwe Mining & Finance Company, B. C. Silver Mines, Ltd., and other affiliated companies. At the recent meeting of the Premier company, it was stated that sufficient ore remained to supply the 500-ton mill until May, 1937, from Premier ore.

✦ Mining and milling at the Cariboo Gold Quartz, near Wells, have been discontinued temporarily as a result of the destruction of the power plant by fire on March 23. New machinery has been ordered.

✦ The shoot of high-grade ore in the River tunnel at the property of Minto Gold Mines, Ltd., in the northern part of the Bridge River field, has been opened for 236 ft., and the face is still in ore assaying 1.75 oz. across a 5-ft. width. The ore averaged 3.22 oz. gold across a width of 5.2 ft. for the first 110 ft. A carload of 41 tons of selected high-grade ore shipped last month to the Tacoma smelter averaged 6.45 oz. gold per ton. The spectacular development has revived interest in this district, and many operations are being started.

✦ At the Bralorne mine, adjoining the Pioneer, ore reserves as of March 31 were 575,000 tons averaging 0.39 oz. gold. In 1935, 145,113 tons of ore was milled, with a net profit, after all deductions, of $500,000. Mill capacity is 475 tons daily.

✦ The new 50-ton flotation mill at the Dividend mine, near Osoyoos, started in March. The property is owned by Osoyoos Mines, Ltd. J. O. Howells is consulting engineer.

✦ At the old Nickel Plate mine, at Hedley, now being operated by the Kelowna Exploration Company, Ltd., there is ore in reserve for five years' operation at the present milling rate of 200 tons a day, with a further possible supply for eight to ten years' operation. A crew of 160 men is employed.

London Reports Tin Merger

Wheal Reeth Absorbs Wheal Breage—Rand Gold Tax Scheme Favorably Received—New Discovery in South Africa Arouses Interest

London Correspondence

ARRANGEMENTS have been concluded for the absorption of Wheal Breage Tin, Ltd., by Wheal Reeth Tin, Ltd., this marking another step in the progress towards a regeneration of the tin-mining industry in Cornwall, England. The price of tin is high enough to make the working of Cornish tin mines generally profitable, but there is still a wide difference of opinion as to whether the props under the price are secure enough to justify the general re-equipment of the mines which is essential to their operation. Those who have confidence in the props and their foundation are working out plans to expand productive activities.

✦ The new plan for the taxation of the Witwatersrand mining profits, which has been presented by the Union of South Africa Government, has been accorded a most favorable reception. Sir Ernest Oppenheimer says it will encourage sane mining and enable the industry to adopt a settled policy. Sir Robert Kotze calls it "a clear, consistent taxation policy which recognizes the realities of the present situation and embodies a long-range policy allowing for fluctuations in the gold price and changes in individual mining practice and conditions and other factors affecting the ration of profits to recovery." Though it will take as much money

from the mining companies as the old one has, and will give advantages to the low-grade mines, it does not penalize the richer mines for treating their high-grade or average-grade ores. The amount which must be paid by any company can be arrived at by taking 50 per cent of its profits and subtracting therefrom 5 per cent of its operating costs, the minimum payment in all cases being 15 per cent of its total profit.

✦ W. A. Mackenzie said of the new tax system, in his address as retiring president of the Transvaal Chamber of Mines: "It is simpler than, and an improvement on, the existing method of taxation, and, as such, is to be welcomed." He maintained, however, that taxation of the mining industry is still far too high, and expressed the belief that a reduction of the scale will come when the new mines now being developed come into production.

✦ Mr. Mackenzie remarked that when the fortieth anniversary of Johannesburg was being celebrated there was some uneasiness as to the future, whereas now the fiftieth anniversary is being celebrated with confidence and optimism. Fifteen new mines are now being opened, with 23 shafts, and 13 new shafts are being sunk on present producers, a total of 36 shafts. Last year's development footage of the Witwatersrand mines was 52,845, as compared with just over 20,000 ft. in 1932.

✦ The Witwatersrand gold output in March was 933,776 oz., being 39,152 oz. greater than in February and the highest total reported since August, 1933. It is being predicted that 1,000,000 oz. per month will be reached soon.

✦ A discovery has been made in the main Witwatersrand area which is eliciting much interest. At a depth of 2,482 ft. in the May shaft, which is on the boundary of Daggafontein and East Daggafontein, a reef of the Kimberley series has been exposed which averages 6.7 dwt. over a width of 44.4 ins. This has caused it to be remembered that five years ago a similarly rich reef was cut at a depth of 2,264 ft. in the Daggafontein No. 3 shaft. At the time little importance was given to the discovery, as the Kimberley reef in that area was assumed to have no economic importance. But now, with this second discovery at approximately the same depth, the possibility of developing what will amount to a new mine is being considered. The two discoveries are 10,000 ft. apart. When the Kimberley shales are reached in the May shaft it can be determined whether the two correspond. In the meantime development of the reef will be started in the May shaft.

✦ Trepca Mines, Ltd., set up another high record in March by treating 53,186 metric tons of ore. Production was 5,831 tons of 80.61 per cent lead concentrates averaging 27.75 oz. of silver per ton, and 7,335 tons of 50.39 per cent zinc concentrates.

Australia's Gold Output Up

Big Bell, at Cue, to Have 1,000-Ton Treatment Plant—Mount Isa Makes First Shipment of Zinc Concentrates

THE SECOND FIELD SEASON of the North Australian aerial, geological and geophysical survey will soon begin. An area of 9,000 square miles will be examined, or three times that covered last year. The geophysical survey is made if warranted and trenching or shallow shaft-sinking carried out. P. B. Nye, government geologist of Tasmania, is in charge.

✦ The Australian gold yield for 1935 is estimated unofficially at 915,994 oz., as compared with 888,558 oz. in 1934 and 830,332 in 1933.

✦ To equip the Big Bell mine, at Cue, W. A., with a 1,000-ton treatment plant, Big Bell Mines, Ltd., is being formed by American and other interests. Since 1932 the mine has been developed by the following: Premier Gold Mining Company, Ltd. (40 per cent interest), American Smelting & Refining Company (40 per cent), Terra Nova Properties, Ltd. (15 per cent interest), and Mining Trust, Ltd. (5 per cent interest). Arrangements have been completed with the Western Australian Government to build a railway 22 miles long from Cue to the mine. The lode is 80 ft. wide and has been proved on the 250-ft. level for a length of 1,300 ft. Average assay is 4½ dwt. The ore is sulphidic, but is amenable to treatment by straight cyanidation. Treatment will comprise coarse and fine crushing, fine grinding and classification, thickening, agitation, filtration, and precipitation of gold in a Merrill-Crowe plant. Dale Pitt, general manager of the Premier, has had charge of development.

✦ The Zinc Corporation, Ltd., Broken Hill, N. S. W., is to sink a new main shaft to 2,500 ft. Recent diamond drilling at depth has given satisfactory results. Sufficient ore is available for 25 years' operation.

✦ Broken Hill Proprietary reopened its lead-zinc mine at Broken Hill, N. S. W., in March, after six years' cessation. The ore is being treated at the Sulphide Corporation's flotation plant.

✦ Mount Isa Mines, Ltd., made its first shipment of zinc concentrates from Townsville, Queensland, during March. The company is now producing 1,300 tons of zinc concentrates weekly from 11,000 tons of crude ore milled.

Labor in Mexico Still Disturbed

Base-Metal Exports, However, Continue at Good Rate—La Consolidada Seeks to Put a Steel and Iron Foundry at the Border

PREPARATIONS for increased activities by some companies, resumption of work by others, and settlements with labor have somewhat lightened the strike-tinged Mexican mining picture in late spring. Such metals as lead, zinc, and copper continue to be exported to Europe on a considerable scale. Ministry of National Economy reports marked increase in production of all leading metals, excepting copper, in 1935, as compared with 1934. These outputs, in kilograms, were, 1935 figures being given first and those of 1934 second, as follows: Gold: 21,223, 20,572; silver: 2,351,087, 2,306,168; copper: 39,372,877, 44,267,805; lead: 184,193,186, 166,332,704, and zinc: 136,021,457, 125,185,936.

✦ Labor authorities denied the Bacis Gold & Silver Mining Company permission to suspend operations near Durango City, deciding it can continue to operate profitably, whereas shutting down would deprive more than 1,000 persons of their livelihood.

✦ Guanajuato Reduction & Mining is still idle owing to the failure to settle the strike that began Nov. 7. Strikers have asked President Cardenas to order confiscation of the mines and give them the property to work on a cooperative basis.

✦ Complaints of miners' unions that Cia. Minera Beneficiadora de Indé, S. A., suspended operations without official authority at its gold-silver properties in Indé and Mineral Cienguilla, Durango, thereby throwing more than 300 men out of employment, are being investigated by the Federal Board of Conciliation and Arbitration. The company says that operations are unprofitable.

✦ Cia. Mexicana Minera de Namiquipa, S. A., averted a strike at its gold, silver, and lead properties near Namiquipa, Chihuahua, by granting increased wages and making other concessions.

✦ American Smelting, Potosi Mining, and Peñoles Mining have assured the Coahuila Government cooperation in its program to afford the town of Aquiles Serdan (Santa Eulalia), adequate water supplies.

✦ La Consolidada, S. A., with a steel plant in Mexico City, operated by Americans, has asked the Tamaulipas State Government for a concession to establish and conduct a steel and iron foundry at Nuevo Laredo, on the American border. The plant will cost $250,000 (United States currency) and employ 100 men.

PERSONAL ITEMS

Dr. T. W. Gevers has been elected to the presidency of the Geological Society of South Africa.

General Sir John du Cane has been appointed deputy chairman of De Beers Consolidated Mines, Ltd.

Dan S. Young is employed by the Castile Mining Company, at Ramsay, Mich., as mining engineer and geologist.

J. Bryant Kasey is acting as mill foreman for the Yarnell Gold Mining Company, Yarnell, Ariz.

Col. D. C. Jackling, president of Utah Copper, recently made an inspection tour of the company's properties in Utah.

Frank J. Hong has resigned from his position as engineer for The Superior Mine, Inc., Valdez, Alaska.

Joe E. Spray has been named mine superintendent for the Tiger mine, at Aguila, Ariz.

Cunningham Dunlop, mining engineer of Ventures, Ltd., recently made an examination of the Tavua gold field in the Fiji Islands.

R. D. Leisk has been appointed assistant manager of Sunshine Mining Company, Beaver Creek, Shoshone County, Idaho.

Sydney H. Ball, of Rogers, Mayer & Ball, who recently returned from an examination in the South, is again in the South on professional business.

LeRoy M. Gross announces that he has recently changed his surname to Otis, having taken his mother's maiden name.

S. L. Ostermeier, geologist and mining engineer of Houston, Tex., is to open an office for consulting practice at Prescott, Ariz.

George D. French, former superintendent of Sheldon Mining, at Walker, Ariz., is operating a property in the Groom Creek district, Prescott.

H. M. Hogan has been elected to the directorate of Argonaut Mining Company, Jackson, Calif., in succession to **E. A. Stent,** who has retired.

Charles M. Romanowitz, sales engineer, Yuba Manufacturing Company, has been elected chairman of the San Francisco Section of the A.I.M.E.

S. G. Turrell, representative in Australia of the American Cyanamid Company, left that country on an overseas visit at the end of March.

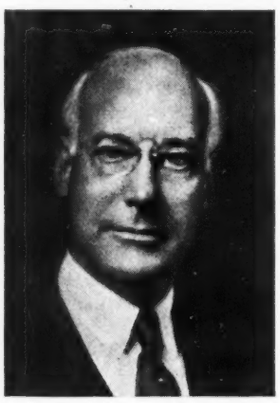
Andrew Meyer has gone to Quebec to examine property for the Bruell Gold Mine Syndicate, Ltd., on the Belle River near Senneterre.

B. W. Skelton has resigned from Rhokana Corporation, Ltd., and has been appointed assistant engineer to Gold Fields Rhodesian Development Company, Ltd.

J. A. Verdussen, after a few months' holiday in Belgium, has gone back to Katanga and may be addressed care of Union Minière du Haut-Katanga, Jadotville, Katanga, Belgian Congo, Africa.

William L. Branch, who has been operating the Wickenburg (Ariz.) ore depot for the past year, will open a similar sampling and purchasing company in Prescott.

Prof. Bradley Stoughton, head of the department of metallurgy, has recently become Lehigh's first Dean of Engineering, by action of the Board of Trustees. As secretary of the American Institute of Mining and Metallurgical Engineers from 1913 to 1921, Bradley Stoughton made a host of friendships throughout the engineering world. During the stress of the War he served on numerous national committees. In 1922,



BRADLEY STOUGHTON

under the administration and support of President Harding, he prepared a report on the twelve-hour day in the steel industry, resulting in the adoption of the eight-hour day. In 1923 he was called to Lehigh to occupy the chair in metallurgy left vacant by the death of Joseph W. Richards. Previous to his Secretaryship, he had been adjunct professor of metallurgy at Columbia with Prof. Henry M. Howe, and while there, in 1908, had written his "Metallurgy of Iron and Steel," for twenty-five years the standard text in this field in the English language. In 1922 he was elected President of the American Electrochemical Society.

J. C. Roxburgh, general manager of Springs Mines (South Africa), has been elected president of the Mine Managers Association. **G. R. Haywood** is vice-president.

H. F. Yuder has left the Monte Christo Gold Silver Company, at Constellation, Ariz., and is now assayer-chemist with Mollin Mining Company, Searchlight, Nev.

T. G. Murdock has severed his connection with Cerro de Pasco Copper Corporation and expects to leave Peru for the United States about the end of May.

W. W. Bradley, State Mineralogist of California, Division of Mines and Mining, San Francisco, is at his home recovering from injuries sustained in a recent automobile accident.

Augustus Locke, consulting geologist directing operations for the Eastern Exploration Company in Nevada, has returned to Goldfield after a brief stay at his office in San Francisco.

H. S. Munroe and **E. V. Neelands** have been appointed directors of Canadian Malartic Gold Mines, in Quebec, which is controlled by Ventures Limited. Mr. Neelands is manager.

T. L. Wells is superintendent of Matachewan Consolidated Mines, in Ontario, which is now firmly established as a profitable venture on its initial 150-ton basis.

F. R. Burton has become field engineer for Mining Corporation of Canada with headquarters at Port Arthur, Ontario, whence he will examine properties in northwestern Ontario and Manitoba.

G. H. Beatty, joint general manager and consulting engineer of Johannesburg Consolidated Investment Company, Ltd., has been elected to the presidency of the South African Chamber of Mines, succeeding **W. A. Mackenzie.**

Charles Franklin Johnson announces his resignation as Assistant Commissioner of Corporations State of California, and his return to private practice of the law, with offices at Suite 650 Subway Terminal Building, Los Angeles.

James E. Moore left California for McCarthy, Alaska, on April 25, where he will be employed as metallurgist by the Bremner Gold Mining Company and will be at that point until at least the middle of October.

J. P. Dick has resigned as mill superintendent with the Kootenay Belle Mining Company at Salmo, B. C., to accept the position of mill superintendent with the Gilles Lake Porcupine Gold Mine, Timmins, Ont.

Curt N. Schuette, consulting engineer, returned to his office in San Francisco from a professional trip to Mexico, during which he visited mining districts on the West Coast, and central and northern Mexico.

D. R. Judd, formerly sales engineer for Hardinge Western Company, is now engineer in charge of the mining and milling department of Joshua Hendy Iron Works, with offices at 206 Sansome St., San Francisco.

S. G. Alderson, of Montreal, has returned to Kenya where he will relieve his brother, **W. P. Alderson,** who has developed west of Victoria Nyanza a gold mine for which a Hadsel mill was ordered recently.

Frank C. Mulford has become associated with Time Corporation, Inc., publishers of *Time* and *Fortune,* as mining consultant in the corporation's research department, with an office at Room 1904, 25 Broadway, New York City.

A. W. Rogers, formerly director of the Union Geological Survey (South Africa), has been awarded the Draper Memorial Medal by the Council of the Geological Society of South Africa, for his notable contributions to the study of South African geology.

G. R. Johnson has resigned from the Tiger Placers Company, operators of a gold dredge in the Breckenridge district of Colorado, to accept a position as mine surveyor with Patiño Mines & Enterprises Consolidated, Inc., at Llallagua, Bolivia, South America.

Leslie L. Motz, with Dairy Farm Gold Corporation, at Lincoln, Calif., until the company discontinued operation owing to exhaustion of the ore, is now employed by the Collins Pacific Company, of San Francisco, and is located at Tombstone, Ariz.

W. H. Munds, formerly general superintendent of Boriana Mining Company, at Yucca, Ariz., is now acting as assistant to Blair Burwell, general superintendent of the United States Vanadium Corporation interests at Naturita, Colo.

H. A. Trice recently left the employment of the Cripple Creek Milling Company, Cripple Creek, Colo., to take a position as shift boss in a 50-ton flotation plant of La Baja Exploration, Engineering & Equipment Company, Phoenix, Ariz.

Frederick B. Hyder recently resigned as manager of Atlas Mines Corporation at Helena, Mont., and has resumed consulting practice. Since concluding a geological examination at Philipsburg, Mont., he is at 591 North Windsor Boulevard, Los Angeles.

Fred N. Marston, general manager for Molybdenum Gold at Mammoth, Ariz., has been transferred to Lead, S. D., to take charge of a property acquired by Molybdenum Corporation of America. He will be succeeded in Arizona by **K. V. Geib,** mine superintendent.

G. C. Barnard, formerly representative and general manager for the Sir Robert Williams group in East Africa, and **Dr. E. Parsons,** who is a well-known authority on East African geology, have set up in practice in East Africa as consulting and managing mining engineers.

Malcolm A. Porter has completed his work at the Alice mine, at Idaho Springs, Colo., and the property has been sold to the American Smelting & Refining Company. Mr. Porter is now engaged on flotation problems at the Cripple Creek Milling Company.

Guy E. Ingersoll, associate professor of mining and metallurgy at Washington State College, Pullman, Wash., accompanied by fourteen junior and senior students, spent May 4 to 8 visiting the mining and metallurgical plants of the Coeur d'Alene district of Idaho.

W. M. Archibald, vice-president of Consolidated Mining & Smelting Company of Canada, has been awarded the McKee Trophy for his services to aviation in Canada during 1935. He directs a fleet of fourteen planes on exploration for his company and is himself a skilled pilot.

Alfred G. White has been named chief of the petroleum division of the United States Bureau of Mines, assuming his duties on May 1. Mr. White was formerly a member of the Bureau staff and more recently with the National Industrial Conference Board, in charge of studies relating to natural resources.

R. E. Barthelemy, consulting mining and ore-dressing engineer, was married last fall in Hongkong to Miss F. V. Robinson, of Chicago. He is now supervising the modernization of the concentrator of a tin mine in the Far East. He intends to revisit the United States next year, after a consulting trip to African and South American mines.

Jesse L. Maury, associate mine valuation engineer with the Federal Securities and Exchange Commission, has been visiting the Commission's offices in Denver, Seattle, San Francisco, and Los Angeles to assist in the instruction of the personnel of the offices in registration work and to discuss the problems of mining registrations with the public.

Col. George E. Cole, Director of Mines of Manitoba, has been elected president of the Canadian Institution of Mining and Metallurgy. **R. G. Drinnan,** Alberta; **W. G. Norrie-Loewenthal,** British Columbia; **Ray S. Jones,** Manitoba and Saskatchewan; **J. C. Nicholson,** Nova Scotia; **E. A. Collins,** Ontario; and **O. C. Smith,** Quebec, have been elected vice-presidents of the Institution.

Sir Lionel Phillips, Bart., and **Dr. James C. Lawn** will be awarded gold medals by the Council of the Institution of Mining and Metallurgy, in recognition of their distinguished services to the mining industry, to commemorate the forthcoming jubilee of the Witwatersrand. **Dr. Munro S. Fisher** will receive the Consolidated Gold Fields gold medal and a premium of 40 guineas for his research on the origin of alluvial gold.

L. A. Wood directs attention to the fact that in his letter on "Tin Concentration in Siam," in the March, 1936, issue of *E.&M.J.*, his signature was printed as "C. A. Wood," and in the sentence regarding the metallurgical investigations of Pinyok ore the word "men" was substituted for the pronoun "me." Opportunity to make correction of these inaccuracies—the results of errors in transcription and in technical analysis of the copy sent to the printer—is appreciated.

OBITUARY

John F. Heeney, well known in mining circles of the West, died on March 28 at Reno, Nev., at the age of 80.

Andrew T. Valcalda, Nevada mining man, died at Tonopah, Nev., on March 10, at the age of 81.

M. J. Hannon, Arizona mining man and promoter, died at Phoenix, Ariz., on March 4.

Vachel Harry McNutt, geologist, widely known for his discoveries of potash, died recently while drilling for oil in New Mexico, at the age of 47.

E. A. Cole, superintendent of the Browns Valley properties of Newmont Mining, in Nevada County, Calif., died recently in Sacramento.

Charles M. Hicks, mining engineer for the Grasselli Chemical Company since 1916, died in Ann Arbor, Mich., on April 7, at the age of 66.

Charles B. Flynn, identified for many years with the mining industry of Arizona, died in San Bernardino, Calif., recently. He was 66 years old.

Henry Bollweg, identified with mining interests in Mexico and Arizona for many years, died in Los Angeles, Calif., on March 2.

James Davis, prominent in mining in California for many years, died in Angels Camp, in that State, recently, at the age of 73.

Irving Allston Palmer, head of the metallurgical department of the Colorado School of Mines, at Golden, Colo., died at Denver on April 29, at the age of 70.

John P. Williamson, mechanical superintendent for Calumet & Arizona and the Copper Queen branch of Phelps Dodge, died at his home in Bisbee, on March 29.

Prof. Edward H. Perkins, glaciologist, and head of the department of geology at Colby College, Waterville, Me., died on April 13 at Waterville, at the age of 50.

William Ruston Percival Parker, prominently associated with the mining industry of Ontario, and a director of the Mining Corporation of Canada, died on April 21 at Toronto, at the age of 64.

W. R. Parker, B.A., K.C., LL.B., for 28 years prominently identified with Canadian mining, and long a director of Mining Corporation of Canada, Ltd., died on April 20 at the age of 64.

L. G. Putnam, an American geologist employed by Inyaminga Petroleum (South Africa), was killed when his plane crashed on March 24 at Somabula, 80 miles from Bulawayo.

Prof. John Scott Haldane, physiologist prominent in research with relation to respiration, air analysis, and mine ventilation on the Rand, died recently at the age of 75.

T. H. Roberts, of Eveleth, Minn., an old pioneer of the Oliver Iron Mining Company, for which he had worked for 52 years, died on April 17 at the age of 68.

Dr. Albert H. Low, 81, retired head of the chemical department of the Colorado School of Mines, and a writer for many technical journals, died in Denver on April 9. He was a graduate of Massachusetts Institute of Technology.

Leslie P. Van Sant, of the St. Louis staff of the McGraw-Hill Publishing Company, and formerly for five years engaged in research for *Engineering and Mining Journal,* was killed in an automobile accident on April 20. Mr. Van Sant was 30 years old and was a graduate of Brown University.

NEW BOOKS

Structure and Metallurgical Treatment Of Metals and Alloys

THE STUDY OF METALS AND ALLOYS. *An Introduction to Physical Metallurgy. By Leland Russell Van Wert, Lecturer on Metallurgy, Harvard University. Pp. 272, 6x9 in., 200 diagrams and photomicrographs. McGraw-Hill Book Company, New York. Price $3.*

At a recent meeting of the Electrochemical Society commemorating the fiftieth anniversary of the discovery of the present method of aluminum reduction, Arthur V. Davis, one of the pioneers, said that the history of the Aluminum Company of America could be divided into four epochs: First, the company had to find out how to make aluminum; second, it had to find somebody to buy the metal; next, it had to find out how to make some money on the transaction; and last, it had to find out something about the metal and what else it could be used for.

This generalization applies equally to the other branches of the metal industry. Probably most readers of *Engineering and Mining Journal* are interested in the first of Mr. Davis's epochs; those men in industries which have progressed to the last of his epochs are the ones who can use Dr. Van Wert's book to advantage. It will tell them something of the methods whereby the investigator studies the inner structure of metals and alloys, and the progress made in systematizing an enormous mass of experimental data. The aim, of course, is to find out what new things the old metals and alloys are good for; how they can be changed by appropriate treatment, either mechanical or thermal; and how new alloys can be devised to meet demands beyond the inherent capacity of the older ones.

Dr. Van Wert joins a distinguished company of metallurgists who have treated this important new branch of an old art. Three countries have already produced books of outstanding merit. In 1914 came "An Introduction to the Study of Physical Metallurgy," by Walter Rosenhain. He gave much attention to the relation of mechanical tests to the microstructure, and so produced a most readable and understandable volume, probably of most "practical" value. Shortly thereafter came "A Text Book of Metallography," by Gustav Tammann (translated from the German in 1925 by Dean and Swenson), which looked upon metals and their alloys from the scientific viewpoint of physical chemistry—pretty stiff reading. Our own countrymen, Zay Jeffries and R. S. Archer, published their "Science of Metals" in 1924. If this notable book can be briefly characterized, it may be said that Jeffries and Archer looked upon a metal as a crystalline aggregate, and discoursed largely on methods of changing the size, orientation, composition, and constitution of these micro-grains, and then explained how such changes affect the mechanical properties of commercial metals.

The book now under review is smaller than any of these predecessors, which, of course, means that many important aspects of the subject are omitted or sketched briefly. On the other hand, the author has had the advantage of a great amount of new information gained with the X-ray. Thus is the search for fundamentals pushed even deeper and to more minute particles than can be seen with the most powerful microscope. Many interesting questions about space lattices, grain fragmentation, and preferred orientation can be solved in this way; Dr. Van Wert's long chapter on the microconstituents of alloys is a masterful summary of our present knowledge about atomic arrangements. It is no disparagement of the book nor of the new science to say that in this respect the researcher is far in advance of the application of his findings to practice—that is, science is far in advance of the art of working, fabrication, and heat-treatment of the common metals. ERNEST E. THUM

Diesel Power

ELEMENTS OF DIESEL ENGINEERING (with questions and answers). *By Orville Adams, consulting diesel engineer. Published, 1936, by Norman W. Henley Publishing Company, Inc., 2 West 45th St., New York, N. Y. Pp. 450; 6x9 in., 284 illustrations. Cloth. Price $4.*

Orville Adams has been writing about diesel engines for years, and in addition has sold and serviced them. Hence he should know something about them. He has here taken his general knowledge, supplemented by careful review of available literature on the subject, and produced a rather comprehensive diesel text. It is designed as a school or home-study text, involving but little thermodynamics or technical mathematics.

The mining engineer using, or planning to use, diesels will find in the first part of this book much material of value. The latter part deals with high-speed engines, largely from the standpoint of automotive and tractor applications, and hence will not be of particular value in a mine plant employing large stationary engines.

Some of Mr. Adams's illustrations are poorly printed and difficult to read. In some cases the drawing has been reduced too much, in others the line cut is poor, the result in either case being undesirable to the reader. This is unfortunate, for Mr. Adams really incorporates many fine operating and maintenance pointers—something which very few diesel books thus far printed have done. He also avoids the catalog character of most diesel texts by discussing fundamental principles instead of devoting a number of chapters to shortened catalog descriptions. This of course means that the engineer will probably find no mention of his specific engine in the book. But general principles and pointers are given which can be interpreted to meet his particular situation. E. J. TANGERMAN.

PUBLICATIONS RECEIVED

Flotation. By V. J. Trushlevich, E.M., professor of ore dressing, Institute of Mines, Moscow, U.S.S.R. A 600-page treatise in the Russian language.

Jade. By Alice V. Petar. U. S. Bureau of Mines. Information Circular 6844. Pp. 16.

Silicosis as Affecting Mining Workmen and Operations. By D. Harrington. U. S. Bureau of Mines Information Circular 6867. Pp. 14.

Slocan Mining Camp, British Columbia. Description of Properties. By C. E. Cairns. Memoir 184, Geological Survey, Canada Department of Mines, Ottawa, Ont. Pp. 274. Price 75c.

Gold Deposits of Elbow-Morton Area, Manitoba. By C. H. Stockwell. Memoir 186, Geological Survey, Canada Department of Mines, Ottawa, Ont. Pp. 74. Price 25c.

Chibougamau Lake Map-area. By J. B. Mawdsley and G. W. H. Norman. Memoir 185, Geological Survey, Canada Department of Mines, Ottawa, Ont. Pp. 95. Price 25c.

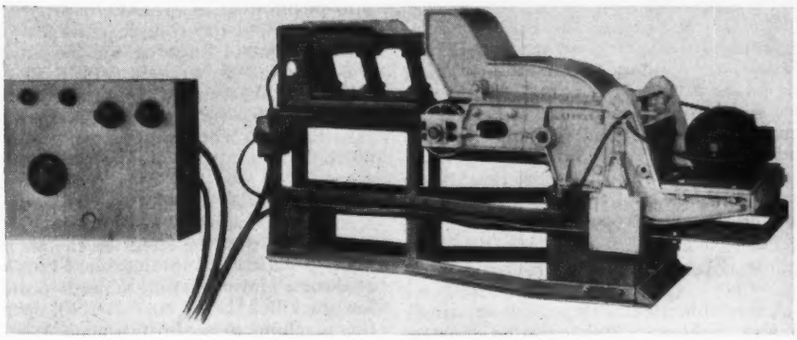
Air Hygiene Foundation of America, Inc., Pittsburgh, Pa. Information Circular No. 1. Purposes and Code of Regulations of the Institute, which has been formed to study air contamination by dust in industrial operations, resulting in silicosis and other diseases.

Bibliography of North American Geology, 1933 and 1934. Bulletin 869. U. S. Geological Survey, Washington, D. C. Pp. 389. Price 40c.

Gold, Silver, Copper, Lead, and Zinc in Idaho. By C. N. Gerry and T. H. Miller. Statistical Appendix to Minerals Yearbook, 1935. U. S. Bureau of Mines, Washington, D. C. Pp. 34. Price 5c.

Junkers and World Aviation. A contribution to German aeronautical history, 1909-1934. Profusely illustrated. Published by Richard Pflaum, Munich, Germany.

EQUIPMENT NEWS



Constant Weight Feeder

A device designated as the Jeffrey-Traylor constant weight feeder has been designed and developed by Jeffrey Manufacturing Company, Columbus, Ohio, for continuously feeding and weighing materials at accurate rates. The unit consists of a vibrating feeder that is controlled electrically by a balanced weighing belt. The scale, or weighing belt, is equipped with an adjustable counterpoise for setting the desired rate of discharge. Moreover, the scale or weighing belt is required to accomplish no other work than to weigh. All gates for regulating the flow of material are eliminated and weighing accuracy is said to be obtained owing to the greater sensitiveness of the scale. In operation, the weighing belt is in perfect balance, as by electrical control; the vibrating feeder is said to be regulated so that the weighing belt is at all times satisfied.

The constant-weight feeder is reported accurate to plus or minus 1 per cent, or less, and can be set to deliver any rate from minimum to maximum and still retain this accuracy. On the control panel flasher lights are at all times said to give visual evidence of correct operation. The unit operates from any alternating-current light circuit. It may be controlled by any number of remote-control devices so that it will follow demand curves. The capacity of the illustrated unit is 3 to 3,000 lb. per hour. The system is said to be adaptable, however, to units of any capacity.

Blueprinting Machine

The new Pease Model 7 continuous blueprinting machine, just announced by the C. F. Pease Company, 813-21 North Franklin St., Chicago, Ill., affords con-

tinuous printing of moderate requirements, reproducing quickly and economically tracings, charts, diagrams, and bulletins in a variety of forms in any dimensions up to 42 in. wide. It is of the horizontal type and is modernly styled in an upright console design with pedestal type base. It is driven by means of a special variable-speed motor, and all speeds are controlled by a 28-point rheostat located at the right-hand side of the machine. An extension cord and detachable plug are provided as standard equipment, and the machine can be connected into any electrical circuit of 20-amp. capacity not exceeding 110 volts a.c. or d.c. Illumination is provided by means of electric mercury-vapor tubes.

Small Displacement Pump

The Homestead Valve Manufacturing Company, of Coraopolis, Pa., announces the development of a miniature triplex plunger reciprocating pump, which handles a small quantity of fluids at relatively high pressure.

Depending upon the speed of the pump, the capacity may be varied from about 15 to 120 g.p.h. The power required by the pump is small, such that a ¼-hp. electric motor will operate the pump at 60 g.p.h. capacity and 200-lb. pressure. It is a single-acting plunger type having three cylinders of ¾-in. bore and ⅝-in. stroke, with the plungers attached to crosshead guides which are driven by connecting rods from the crankshaft. The monel-metal inlet valves are of the poppet type, positively actuated through a cam-and-tappet mechanism and the outlet check valves are of the ball type with adjustable limited lift for high-speed operation. Gears, crankshaft, connecting rods, and crossheads are entirely inclosed in a crankcase with splash lubrication.

It is said to be adaptable to a great variety of uses such as boiler feed, boiler-compound injection, condensate returns, small hydraulic presses, fuel-oil pumps for oil burners, pumping of chemicals, air-conditioning apparatus, and control apparatus.

Rocking Furnace Control

A step forward toward a completely automatic furnace for controlled electric melting is announced by the Detroit Electric Furnace Company, 825 West Elizabeth St., Detroit, Mich. This improvement, which will be embodied as standard equipment on new models for 1936, is said to provide a means for controlling the rocking cycle of the furnace automatically, to compensate for differences and variations in the charge. The melting variables in a foundry fall into several classes, such as the following differences: the physical characteristics of the charge, the specific heat of the charge, chemical composition, total weight, and variations in tapping temperature. The new automatic rocking control Type AR-1 is said to enable the furnace operator to predetermine and repeat the rocking cycle which is most advantageous metallurgically and thermally. Lining costs are said to be reduced, in that the roof and hearth of the furnace may be alternated on successive heats, thereby equalizing lining wear.

This new device enables the operator to bring the furnace to full rock automatically in the shortest possible time, so that the charge may be melted rapidly, utilizing the heat stored in the lining as well as that directly from the arc. The new mechanism, is said, therefore, to improve thermal economy and aid in reducing melting costs.

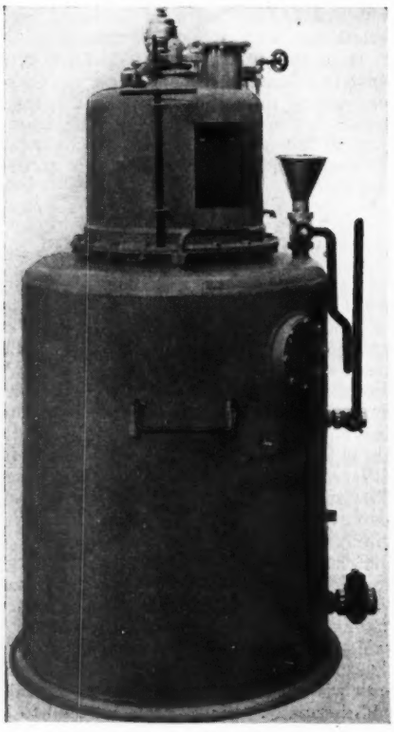
Tape Rule

The Lufkin Rule Company, of Saginaw, Mich., has placed an all-purpose 6-ft. steel-tape rule on the market, known as the "Mezurall." Common measuring, either butt end or hook, is done in the usual way. To take an inside measurement, butt the square back edge of the case against one side of the opening being measured, extend the blade to the other limit, and add 2 in. to the reading clearly indicated at the square opening of the case, as the case is exactly 2 in. wide.

The end hook has a short sliding action, thereby automatically adjusting itself to give accurate results when hooked over any object. The rule is said to stand unsupported and is flexible and can be conveniently carried in the pocket.

Small Medium-Pressure Generator

A new small-size medium-pressure acetylene generator for portable or stationary service has been announced by The Linde Air Products Company, 30 East 42d St., New York City. Known



as the Oxweld Type MP-6 medium-pressure generator, this equipment has a 50-lb. carbide capacity with a double rating of 100 cu.ft. of acetylene per hour. Developed for portable or stationary use, it meets the demand for small, rugged, low-priced generating equipment of modern design.

A hand wheel at the generator top makes it possible to control the carbide feed so that acetylene at any desired pressure up to 14 lb. per square inch may be obtained. The use of pressed-steel parts and bronze-welded galvanized-steel sheet results in a sturdy and compact unit. Automatic controls are said to make the Oxweld Type MP-6 generator particularly safe to operate.

The generator can be mounted on a truck for transportation from job to job, or fitted for permanent installation to supply medium-pressure acetylene through pipe lines.

Air-Operated Indicator Controller

For pressure- and temperature-control applications not requiring a record of the factor under control, Bailey Meter Company, of Cleveland, Ohio, has developed an Indicator-Controller which may operate either a diaphragm motor valve or an air-operated control drive. This controller is housed in a 13-in. diameter round casing and may be mounted either flush on a panel or on a wall or column. It incorporates an indicating pointer and scale graduated to measure the factor under control. A second pointer indicates the standard for which the controller is set, so that the two pointers coincide when the controller is in operation. An adjustment is provided whereby the sensitivity or "control range" may be varied from 1 to 1,000 per cent of the measuring range.

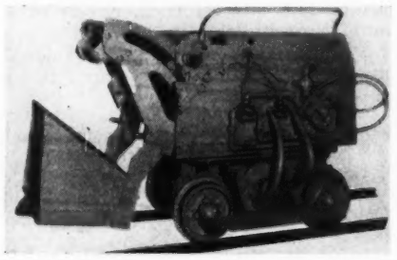
Inside the casing, a Bourdon-tube type pressure spring actuates both the indicating pointer and a free floating air-pilot valve. Inlet and outlet air pressures to this pilot are indicated by small gages on either side of the main indicating dial, and connections for air supply and control pressure are made through the rear of the casing with $\frac{1}{4}$-in. outside diameter copper tubing.

Electric Screwdriver

A portable electric screwdriver, small in size, light in weight, and said to be capable of driving all sizes of screws from No. 4 to No. 12 by simply changing the finder and bit, has been announced by the Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, Ill. This new Thor U16 electric screwdriver is said to be different in design and construction, following the design of the U14, smallest electric drill ever built, recently announced, and incorporates features never before built into an electric screwdriver. All weight is said to be concentrated at the operator's hand, eliminating overhanging weight. The size of the screwdriver, which is $10\frac{1}{2}$ in. over all, permits uses in places ordinarily inaccessible. A powerful motor, dependable tension adjustment, hand-wound armature, and special commutator construction are said to provide efficient operation.

Self-Propelled Mechanical Shovel

A new mechanical shovel, known as the Eimco-Finlay Model 20 loader, for use in large drifts and tunnels, has been introduced by the Eimco Corporation, 634-666 So. Fourth West St., Salt Lake City, Utah. It is said to show good ef-

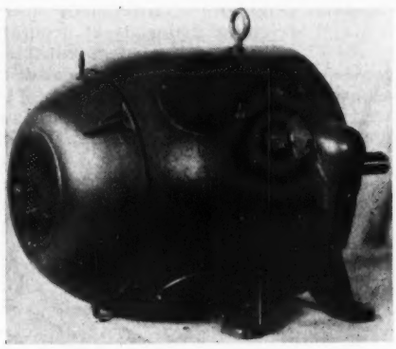


ficiency and to cost little to operate and maintain. Compactness, large capacity, and flexibility of operation are outstanding features of the design. The machine operates on track gages from 24 to 42 in. and can be furnished to load cars having a maximum height above rails of 66 in. and of standard car length. Self-tramming, it provides a fast, flexible unit for miners and contractors.

The Model 20 loader is fitted with electric heat-treated alloy-steel castings throughout, Timken and SKF roller bearings, tool-steel gears, and air motors designed especially for the work by Ingersoll-Rand. It operates with equal ease and offers the same flexibility as does the smaller unit manufactured by the company, known as the Model 11. In construction, the new model is twice as heavy as the latter loader. Power for loading and crowding is furnished by two I-R air motors, each fitted and keyed into position so as to make it practically immovable to the roughest usage. The central control situated on the side of the machine is so arranged that each motor is answerable to the operator's every wish through a quick-acting throttle. Air consumption ranges from 60 to 140 cu.ft.. per minute at pressures from 70 to 100 lb. The sensitivity of the air throttles and the speedy response are said to reduce the duration of air demand, so that the effect on the air supply is practically unnoticeable. Simplicity of design and operation make it possible for unskilled labor to learn to operate the machine in a short time.

Fan-Cooled Motor

A fan-cooled totally inclosed direct-current motor has been developed by the Westinghouse Company, East Pittsburgh, Pa. It has an external fan and



shroud on the commutator end, with the same accessibility to armature as on straight totally inclosed motors. The removal of but one cover from a bracket opening permits accessibility to the brushes. This is accomplished by casting integrally the inner supporting bearing bracket and the outer air shroud. The combination bracket therefore has air passageways between the shroud and the inner bracket except at the inspection openings. This construction is said to permit the use of an external blower on the commutator end, without the disadvantage of having to remove two covers to examine the commutator. The blower is on the commutator end and not the pinion end, which permits mounting it snugly against a gear case or other wall. It is of cast aluminum with a split hub and keyed to the shaft.

Mine-Locomotive Headlights

Mine-locomotive headlights which meet the demand for small, sturdy lights suitable for use on haulage or gathering electric locomotives, surface equipment, and similar applications, have been announced by the Westinghouse Electric & Manufacturing Company. Designed to withstand the impact of falling coal or rocks, they are built of one-piece semi-steel to withstand the most severe operating conditions.

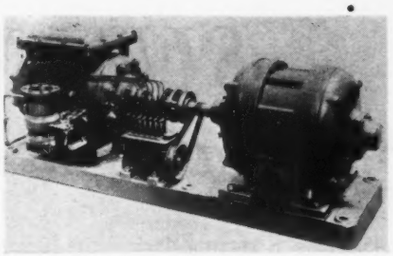
The permissible type is explosion-tested suitable for use in gaseous mines subject to certified approval by the United States

Bureau of Mines. It differs from the standard type only in door frame and wiring. At least one inch of actual creepage is allowed in all joints, so that any gases ignited within the headlight will be cooled before reaching the outside. A cable packing gland and hose clamp permitting inclosed wiring in rubber hose $1\frac{1}{16}$ in. outside diameter are located in the center of the back of mounting on either right or left side of locomotive.

The lens is of $\frac{1}{2}$-in. heat-resisting glass. The reflector, designed for maximum acceptance of light from the lamp, is constructed of spun brass with a chromium-plated reflecting surface. A medium-base multiple lamp socket equipped with bronze lamp grips is mounted inside the body on a shock-absorbing support. A standard 56- or 94-watt lamp of 105-130 volt rating is used.

Rotary Air Compressor

Allis-Chalmers announces a new line of two-stage sliding-vane rotary air compressors for gage pressures up to 100 lb. The design is unique in that both stages as well as the inter-cooler are contained in a single casing. Compared with the usual design of two-stage rotary having two separate cylinders, it is said to offer the advantages of reduced length and floor space, less weight, only one stuffing box and one coupling, no external air piping between stages to keep tight, and a simpler lubrication system. Having only two bearings and one flexible coupling, alignment is reported easily maintained. A complete line of this type of air compressor has been developed, from 20 hp. 1,740 r.p.m. to 100 hp. 690 r.p.m., for actual air deliveries from 69 to 412 cubic feet per minute at air-gage pressure of 100 lb.



BULLETINS

Unit Heaters. American Blower Corp., Detroit, Mich. Bulletin No. A-5018. Description of new Venturafin heater equipped with a epicycloidal aluminum fan. Installation drawings, graphs, and charts. Pp. 48.

Tertiary Gravel Map. The U.S.G.S. has reprinted Waldemar Lindgren's map of the Tertiary stream channels in California. To be obtained from the Director United States Geological Survey. Price 50c.

Crushers. Traylor Engineering & Mfg. Co., Allentown, Pa. New Bulletin 112. Reduction crushers of the gyratory type and instructions for erection, lubrication, adjustment, and repair. Pp. 13

Mercury Vapor Lamps. Benjamin Electric Mfg. Co., Des Plaines, Ill. Bulletin illustrating mercury vapor lamps and fixtures for industrial lighting. Pp. 27.

Alemite Lubrication Manual. Alemite, 1873 Diversey Parkway, Chicago. A book explaining lubrication maintenance of machinery.

Diesel Electric Generator Sets. Caterpillar Tractor Co., Peoria, Ill. Pamphlet, Form 3105. Electric current for isolated mines or communities. Pp. 7.

Dust Collectors. Pangborn Corp., Hagerstown, Md. Bulletin 197. Type "CH," all-metal, cloth-screen dust collector. Booklet illustrates new features of this type of equipment. Pp. 24.

Wide Strip Pyrometer. Bristol Co., Waterbury, Conn. Illustrated folder of pyrometer operating on the potentiometer principle of temperature measurement.

Centrifugal Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. Folder W-321-B8. Pumping volatile liquids against medium heads. Pp. 3.

Magnetic Contactors. Electric Controller & Mfg. Co., Cleveland, Ohio. Folder 1140. Contactors of aluminum alloy for alternating current. Pp. 3.

Valves. Haynes Stellite Co., Kokomo, Ind. Booklet 2879. Valves for high temperatures and pressures or for service where corrosion and erosion are encountered. Pp. 8.

Mixers. Mixing Equipment Co., Inc., Rochester, N. Y. Bulletin 53. Portable and permanent agitators and mixers. Pp. 4.

Automatic Controls. Mercoid Corp., 4201 Belmont Ave., Chicago, Ill. General abridged catalog No. 100 for heating, air conditioning, refrigeration, and industrial applications. Pp. 24.

Bronze-Welding. Linde Air Products Co., 205 East 42d St., New York, N. Y. A presentation of fundamental theory and technique of bronze-welding and bronze surfacing. Booklet entitled "How to Bronze-Weld." Pp. 10.

Air-Cooled Portable Compressors. Ingersoll-Rand Co., Phillipsburg, N. J. Catalog No. 3164 illustrating compressors of two-stage air-cooled types, also construction details of units, and paving breakers, rock drills and pneumatic tools. Pp. 32.

Jaw Crushers. Traylor Engineering & Mfg. Co., Allentown, Pa. Bulletin 105, containing illustrations and capacity charts of Type H Blake jaw crushers. Pp. 9.

Spray Nozzles. Chain Belt Co., Milwaukee, Wis. Bulletin 278 illustrating nonclogging spraying devise. Pp. 3.

Portable Plants. Smith Engineering Works, Milwaukee, Wis. Bulletin 269 illustrating various plans of crushing, screening, and conveying set-ups. Pp. 15.

Steel Belt Lacing. Flexible Steel Lacing Co., 4607-31 Lexington St., Chicago, Ill. Folder "E" illustrating sizes of steel-belt lacing, together with price list.

Mineral Jig. Denver Equipment Co., 1419 17th St., Denver, Colo. Bulletin No. 3622. Folder illustrating installations of mineral jigs. Pp. 4.

Centrifugal Pumps. Morris Machine Works, Baldwinsville, N. Y. Bulletin 157 illustrating hydraulic dredge machinery, pumps and steam engines, also contains some useful hydraulic tables. Pp. 15.

Friction Material. Manhattan Rubber Manufacturing Co., Passaic, N. J. Booklet of tables and general information on friction material requirements for cranes, dredges, hoists, elevators and wood brake and clutch blocks. Pp. 11.

Magnetic Separator. Frantz Ferro-Filler, Separations Engineering Corporation, 110 East 42d St., New York City. Description of equipment which removes iron bearing particles from liquids. Pp. 5.

Conveyometers. Richardson Scale Company, Clifton, N. J. Bulletin 1629-G illustrating and describing equipment that will self-weigh, self-register and convey material from any overhead source. Pp. 31.

Pneumatic Tools. Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin 2219 featuring the I-R Impact Wrench and various types of pneumatic tools for industrial and construction purposes. Pp. 16.

INDUSTRIAL NOTES

A. E. Perkins has been appointed Western Division manager for the Crucible Steel Company of America, and in this capacity will have jurisdiction over the Western sales branches of the company, including those at Denver, Los Angeles, San Francisco, Portland, and Seattle. His offices at Denver are 2635 Walnut St.

The Central Foundry Company announces the removal of its Pacific Coast sales office from San Francisco to 278 Fourth St., Oakland, Calif.

Link-Belt Company announces the removal of its district sales office in St. Louis, Mo., from 3638 Olive St. to 1018-21 Louderman Building, 317 N. 11th St. Howard L. Purdon is district sales manager.

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., announces the appointment of the Markham Supply Company, 310 S. Michigan Ave., Chicago, Ill., as its general railway sales representatives for the Chicago, St. Louis, Kansas City, Omaha, and Twin Cities territory.

Two Cleveland welding firms were merged as of Jan. 1, 1936, when Contract Welders, Inc., 4829 Lexington Ave., acquired the Industrial Welding & Cutting Company, 4400 Perkins Ave. The two plants were operated as divisions of Contract Welders, Inc., until April 1, when equipment and organization were consolidated as Contract Welders, Inc., in large quarters at 2545 E. 79th St., Cleveland.

Precipitation Company of Canada, Ltd., has been organized with offices at Dominion Square Building, 1010 St. Catherine St., West Montreal P. O., according to an announcement by the Western Precipitation Company, of Los Angeles, Calif.

Rolf E. Ljungkull has been appointed vice-president of the American Hoist & Derrick Company to fill the vacancy created by the retirement of Howard S. Johnson.

James Cleary has been appointed special representative in the Power Equipment Division of the Foster-Wheeler Corporation, 165 Broadway, New York, N. Y.

E. T. Bennington, formerly connected with the Cleveland Tramrail Company, has joined the Chicago office of the Harnischfeger Corporation as a sales engineer specializing in cranes and hoists.

Lincoln Electric Company, Cleveland, Ohio, announces the moving of its Pittsburgh office, formerly at 323 Fourth Ave., to larger quarters at 926 Manchester Boulevard, Pittsburgh, Pa.

Roots-Connersville Blower Corporation, of Connersville, Ind., announces that its Chicago branch office is now located in the Marquette Building, 140 South Dearborn St., in charge of William Townsend, district manager.

The International Nickel Company, Inc., has announced the establishment of field representatives at 333 North Michigan Ave. Building Chicago, Ill., and 705 Petroleum Securities Building, Los Angeles, Calif.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

APRIL was all copper so far as trading in non-ferrous metals was concerned. As soon as it became certain that the quotation of copper would be raised one-quarter cent by those sellers who had been holding to the 9¼c. basis, a buying wave of the first magnitude struck the industry and absorbed a huge tonnage, including a substantial quantity of metal that had hung over the market for several years. In the comparatively short period of four days, immediately preceding the date set for the advance, about 130,000 tons of copper were sold, mostly for July shipment to consumers.

Sales of copper in the domestic market for April totaled 158,064 tons, which compares with the previous monthly high established in May, 1930, of about 156,500 tons. Domestic sales averaged 76,457 tons a month during the first four months of the current year. This compares with a monthly average of 48,040 tons for all of 1935.

The higher selling basis for copper, 9½c., Valley, was put into effect on April 14. So-called unfilled orders, based on consumption of about 53,500 tons a month, the rate actually established in the first quarter of the year, are the equivalent of more than four months' requirements of fabricators. However, producers and fabricators are confident that consumption of copper will continue to rise and are talking of even higher prices later in the year. There appears to be no concern whatever over the ability of producers to keep output in check.

Domestic stocks of copper at the end of March amounted to 238,601 tons, of which total 150,376 tons consisted of metal owned by producers. World stocks, producer and non-industry copper, totaled 483,296 tons at the end of March, against 481,350 tons a month previous and 485,300 tons at the end of 1935.

Activity in lead was below the average until the last week of the month, when more than 10,000 tons were sold by producers. The price was maintained at 4.60c., New York, and 4.45c., St. Louis.

Zinc was depressed somewhat by the unsettlement in the London market. Statistically, the domestic situation remains strong.

Our index number of non-ferrous metals prices for April was *72.27*, against 71.90 in March, and 74.73 in April last year.

United States Market

1936 April	Electrolytic Copper Domestic (a)	Electrolytic Copper Export (b)	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	9.025	8.750	47.600	4.60	4.45	4.90
2	9.025	8.775	47.650	4.60	4.45	4.90
3	9.025	8.775	47.625	4.60	4.45	4.90
4	9.025	8.775	47.550	4.60	4.45	4.90
6	9.025	8.775	47.500	4.60	4.45	4.90
7	9.025	8.775	47.125	4.60	4.45	4.90
8	9.025	8.800	46.950	4.60	4.45	4.90
9	9.025	8.825	46.900	4.60	4.45	4.90
10	9.025	8.850	46.875	4.60	4.45	4.90
11	9.025	8.850	46.875	4.60	4.45	4.90
13	9.025	8.850	47.125	4.60	4.45	4.90
14	9.275	8.900	47.125	4.60	4.45	4.90
15	9.275	8.900	47.000	4.60	4.45	4.90
16	9.275	8.850	46.500	4.60	4.45	4.90
17	9.275	8.850	46.600	4.60	4.45	4.90
18	9.275	8.875	46.875	4.60	4.45	4.90
20	9.275	8.875	46.875	4.60	4.45	4.90
21	9.275	8.900	46.875	4.60	4.45	4.90
22	9.275	8.875	46.875	4.60	4.45	4.90
23	9.275	8.900	46.625	4.60	4.45	4.90
24	9.275	8.900	46.600	4.60	4.45	4.90
25	9.275	8.925	46.625	4.60	4.45	4.90
27	9.275	8.925	46.700	4.60	4.45	4.90
28	9.275	8.900	46.725	4.60	4.45	4.90
29	9.275	8.875	46.625	4.60	4.45	4.90
30	9.275	8.825	46.625	4.60	4.45	4.90
Av. for month	9.169	8.849	46.963	4.60	4.45	4.90
Averages for Week						
1	9.025	8.688	47.425	4.60	4.45	4.90
8	9.025	8.779	47.400	4.60	4.45	4.90
15	9.108	8.863	46.983	4.60	4.45	4.90
22	9.275	8.871	46.767	4.60	4.45	4.90
29	9.275	8.904	46.650	4.60	4.45	4.90
Calendar Week Averages						
4	9.025	8.754	47.479	4.60	4.45	4.90
11	9.025	8.813	47.038	4.60	4.45	4.90
18	9.233	8.871	46.871	4.60	4.45	4.90
25	9.275	8.896	46.746	4.60	4.45	4.90

Silver, Gold, and Sterling Exchange New York and London

1936 April	Sterling Exchange "Checks"	Sterling Exchange 90-day Demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.95250	4.94500	44.750	19.9375	140s 8 d	$35.00
2	4.95500	4.94750	44.750	20.0000	140s 7 d	35.00
3	4.95500	4.94750	44.750	20.0000	140s 7½d	35.00
4	4.95250	4.94625	(e)	19.9375	140s 7 d	35.00
6	4.95250	4.94625	44.750	19.8750	140s 6½d	35.00
7	4.94750	4.94125	44.750	19.9375	140s 8½d	35.00
8	4.94375	4.93750	44.750	19.8750	140s 10 d	35.00
9	4.94000	4.93500	44.750	20.0625	140s 10½d	35.00
10	4.94250	4.93750	44.750	——Holiday——		35.00
11	4.93875	4.93375	(e)	——Holiday——		35.00
13	4.94000	4.93500	44.750	——Holiday——		35.00
14	4.94000	4.93500	44.750	20.0625	140s 10 d	35.00
15	4.94125	4.93625	44.750	20.2500	140s 10 d	35.00
16	4.94000	4.93500	44.750	20.4375	140s 10½d	35.00
17	4.94000	4.93500	45.000	20.7500	140s 10 d	35.00
18	4.94000	4.93500	(e)	20.8750	140s 10½d	35.00
20	4.93875	4.93375	45.750	20.5000	140s 10 d	35.00
21	4.93750	4.93250	45.500	20.5625	140s 9½d	35.00
22	4.93500	4.93000	45.250	20.2500	140s 11 d	35.00
23	4.93125	4.92625	45.125	20.3750	141s ½d	35.00
24	4.93250	4.92750	45.000	20.4375	140s 11½d	35.00
25	4.93625	4.93125	(e)	20.3750	140s 11 d	35.00
27	4.93500	4.93000	44.750	20.3750	140s 10½d	35.00
28	4.93500	4.93000	44.750	20.2500	140s 10½d	35.00
29	4.93625	4.93125	44.750	20.1875	140s 9½d	35.00
30	4.93750	4.92125	44.750	20.3125	140s 9½d	35.00
Av. for month	4.94139	.....	44.892	20.245	.....	35.00
Averages for Week						
1	4.95021	.....	44.750	.....	.....	.....
8	4.95104	.....	44.750	.....	.....	.....
15	4.94042	.....	44.750	.....	.....	.....
22	4.93854	.....	45.250	.....	.....	.....
29	4.93438	.....	44.875	.....	.....	.....

Calendar week averages: New York Silver, April 4th, 44.750; 11th, 44.750; 18th, 44.800; 25th, 45.325.

(e) No quotation.

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936 April	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	36.4375	36.6875	40.6250	213.0000	206.2500	16.3750	16.5625	15.6250	15.8750
2	36.4375	36.6875	40.6250	213.7500	206.7500	16.3750	16.5625	15.6250	15.8750
3	36.5000	36.8125	40.6250	214.5000	206.0000	16.3750	16.5625	15.5000	15.7500
6	36.5625	36.8125	40.6250	214.5000	206.2500	16.1875	16.4375	15.3750	15.6250
7	36.6250	36.9375	40.7500	212.5000	205.0000	16.1250	16.4375	15.3750	15.6250
8	36.6875	37.0000	41.0000	211.0000	203.7500	15.9375	16.1875	15.1875	15.4375
9	36.8750	37.1875	41.0000	210.5000	203.7500	15.9375	16.1250	15.1250	15.3750
10	Holiday								
13	Holiday								
14	37.1875	37.5000	41.2500	210.5000	204.0000	16.0625	16.2500	15.1250	15.3750
15	37.1875	37.5000	41.5000	209.5000	203.7500	16.0000	16.1875	15.0625	15.3125
16	36.9375	37.2500	41.0000	207.0000	202.0000	15.9375	16.1250	14.8750	15.0625
17	37.1250	37.3750	41.3750	207.0000	202.5000	15.8750	16.0625	14.9375	15.0625
20	37.2500	37.5625	41.6250	207.5000	203.2500	15.7500	15.9375	15.0625	15.0625
21	37.0625	37.3750	41.2500	207.0000	202.7500	15.9375	16.0000	15.0625	15.0625
22	37.1250	37.3750	41.2500	206.5000	202.7500	16.0000	16.0625	15.1250	15.1875
23	37.5000	37.6875	41.5000	206.2500	202.7500	16.0625	16.1875	15.3750	15.3750
24	37.4375	37.7500	41.5000	206.2500	202.5000	16.0625	16.1875	15.1250	15.2500
27	37.5000	37.7500	41.5000	206.5000	202.5000	16.3125	16.3750	15.1250	15.2500
28	37.1875	37.5000	41.2500	207.0000	202.7500	16.2500	16.2500	15.0000	15.1250
29	37.0000	37.3125	41.3750	207.7500	202.2500	16.2500	16.1875	15.0000	15.0000
30	36.8750	37.1875	41.0000	207.7500	202.0000	16.1250	16.0000	14.9375	15.0000
Av. for month...	36.975	.....	41.131	209.313	.....	16.097	16.234	15.181	15.334

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated.

(May 1, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb.	19@21c
Antimony, domestic spot, lb.	12.625
Bismuth, ton lots, lb.	$1.80
Cadmium, lb.	$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$32.00
Quicksilver, flask of 76 lb., 100 flasks or more	$76.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.00@$16.50
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range, non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent, Joplin, Mo., ton	$49.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent.	26c.
49@51 per cent.	26c.
44@47 per cent.	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$16.00@.....
Domestic Scheelite	$16.00@.....
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$32.00

Metallic Compounds

Arsenious Oxide (arsenic) lb.	3½c.
Cobalt Oxide, 70@71 per cent, lb.	$1.29@$1.39
Copper Sulphate, 100 lb.	$4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.29
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained.	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a) $5.50@ $7.00
French, 56@59 per cent	(a) $6.50@ $7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$22.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½x2in.	15@30c.
2x2in.	30@50c.
3x3in.	75@ $1.00
3x4in.	$1.00@$1.25
4x6in.	$2.00@ $2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@ 12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$28.00
Structural shapes, 100 lb.	$1.80
Bars, 100 lb.	$1.85

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	.....	33.865	.....	488.587	.....
June	71.940	.....	32.346	.....	493.245	.....
July	68.216	.....	30.500	.....	495.558	.....
August	66.366	.....	29.476	.....	496.815	.....
September	65.375	.....	29.255	.....	492.917	.....
October	65.375	.....	29.368	.....	490.577	.....
November	65.375	.....	29.284	.....	492.277	.....
December	58.420	.....	25.563	.....	492.715	.....
Year	64.273	.....	28.952	.....	490.034	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery				London Spot			
	Electrolytic						(a)	
	Domestic		Export		Standard		Electrolytic	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	.....	7.794	.....	33.344	.....	36.733	.....
June	8.634	.....	7.307	.....	30.799	.....	34.039	.....
July	7.775	.....	7.350	.....	31.024	.....	34.261	.....
August	7.979	.....	7.738	.....	32.646	.....	35.976	.....
September	8.504	.....	8.146	.....	34.036	.....	37.952	.....
October	8.967	.....	8.514	.....	35.226	.....	39.609	.....
November	9.025	.....	8.414	.....	35.229	.....	39.396	.....
December	9.025	.....	8.414	.....	35.097	.....	39.313	.....
Year	8.649	.....	7.538	.....	31.867	.....	35.430	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

Lead

	New York		St. Louis		London			
	1935	1936	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos.
January	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.494
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	.....	3.812	.....	13.861	13.940	.....	.....
June	4.020	.....	3.870	.....	13.776	13.806	.....	.....
July	4.123	.....	3.973	.....	14.451	14.511	.....	.....
August	4.254	.....	4.104	.....	15.774	15.792	.....	.....
September	4.413	.....	4.263	.....	16.262	16.315	.....	.....
October	4.512	.....	4.362	.....	18.209	18.209	.....	.....
November	4.500	.....	4.350	.....	17.938	17.935	.....	.....
December	4.500	.....	4.350	.....	16.803	16.828	.....	.....
Year	4.065	.....	3.915	.....	14.238	14.326	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits New York		Standard, Spot London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	.....	227.602	.....
June	51.108	.....	227.586	.....
July	52.297	.....	232.397	.....
August	50.463	.....	222.935	.....
September	49.126	.....	223.929	.....
October	51.160	.....	226.891	.....
November	51.864	.....	226.452	.....
December	49.794	.....	220.075	.....
Year	50.420	.....	225.473	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos.
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	.....	14.534	14.685	.....	.....
June	4.299	.....	13.734	13.898	.....	.....
July	4.325	.....	14.065	14.185	.....	.....
August	4.535	.....	14.714	14.938	.....	.....
September	4.669	.....	15.414	15.616	.....	.....
October	4.825	.....	16.440	16.674	.....	.....
November	4.850	.....	16.193	16.372	.....	.....
December	4.850	.....	15.091	15.278	.....	.....
Year	4.328	.....	14.082	14.269	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	.....	20.000	.....
June	65.000	.....	20.000	.....
July	65.000	.....	20.000	.....
August	70.000	.....	20.000	.....
September	75.625	.....	20.000	.....
October	85.000	.....	20.000	.....
November	85.000	.....	20.000	.....
December	101.800	.....	20.000	.....
Year	70.491	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	.....	72.135	.....	32.000	.....
June	12.500	.....	71.460	.....	32.000	.....
July	12.500	.....	70.538	.....	32.000	.....
August	12.500	.....	69.000	.....	31.333	.....
September	13.177	.....	69.208	.....	36.000	.....
October	15.322	.....	71.750	.....	37.615	.....
November	14.217	.....	74.348	.....	38.000	.....
December	13.820	.....	75.200	.....	38.000	.....
Year	13.616	.....	71.992	.....	34.150	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lo. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	.....	18.00	.....	18.50	.....
June	19.00	.....	18.00	.....	18.50	.....
July	19.00	.....	18.00	.....	18.50	.....
August	19.00	.....	18.00	.....	18.50	.....
September	19.00	.....	18.00	.....	18.50	.....
October	19.00	.....	18.00	.....	18.50	.....
November	20.00	.....	19.00	.....	19.50	.....
December	20.00	.....	19.00	.....	19.50	.....
Year	19.167	.....	18.167	.....	18.667	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.